100/200W

VZC-6963G1B

operating and service manual

for satellite communications terminal equipment

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100/200W
GENERAL
PURPOSE
WIDE BAND
TWTA

MODEL NO.

VZC-6963G1B

Operating
and
Service
Manual

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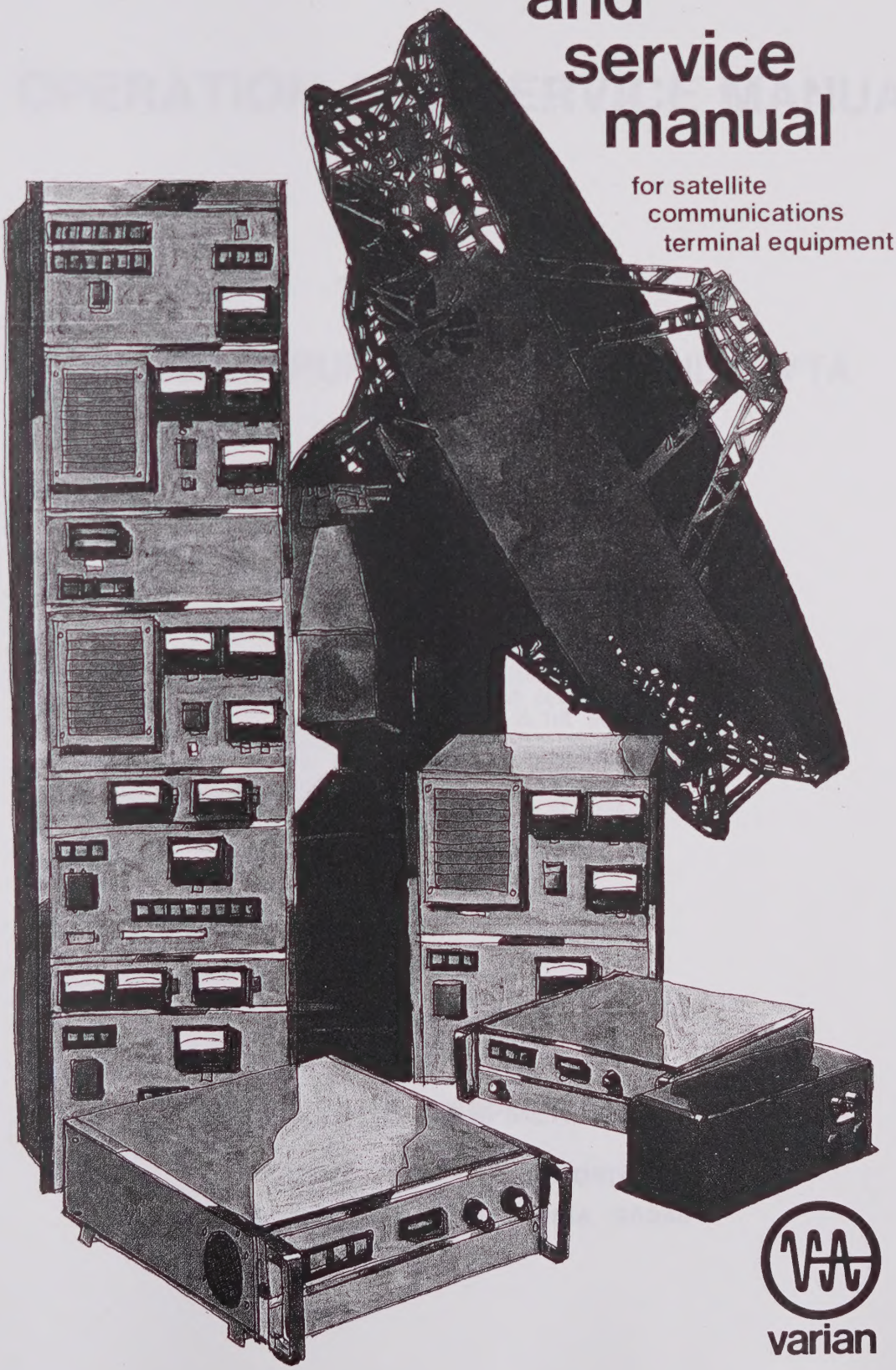
operating and service manual

for satellite communications terminal equipment



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OPERATION AND SERVICE MANUAL

FOR

100/200 WATT

GENERAL PURPOSE WIDE BAND TWTA

PROPRIETARY

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VARIAN ASSOCIATES

MICROWAVE EQUIPMENT DIVISION

3200 PATRICK HENRY DRIVE

SANTA CLARA, CALIFORNIA 95050

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SAFETY SUMMARY

THIS EQUIPMENT HAS BEEN DESIGNED TO MINIMIZE EXPOSURE OF PERSONNEL TO SAFETY HAZARDS. THE NATURE OF THE EQUIPMENT IS SUCH THAT THERE ARE CERTAIN INHERENT HAZARDS THAT REQUIRE THAT THE OPERATOR OR TECHNICIAN WORKING WITH THIS EQUIPMENT HAVE CERTAIN SPECIFIC TRAINING AND KNOWLEDGE. THE RF AMPLIFIER TUBES USED IN THE EQUIPMENT OPERATE WITH HIGH VOLTAGE POWER SUPPLIES AND DELIVER HIGH LEVELS OF MICROWAVE ENERGY. OPERATORS OR TECHNICIANS THAT WORK WITH THIS EQUIPMENT MUST BE TRAINED IN THE USE OF SUCH EQUIPMENT AND FAMILIAR WITH THIS PARTICULAR UNIT. GUIDELINES FOR DEALING WITH SAFETY HAZARDS ARE INCLUDED IN THE SUPPLEMENTARY DATA SECTION OF THIS MANUAL. YOU SHOULD BECOME FAMILIAR WITH THESE GUIDELINES PRIOR TO OPERATING OR SERVICING THE EQUIPMENT.

PLEASE READ AND OBSERVE THE FOLLOWING CAUTIONS AND WARNINGS THAT ARE CONTAINED IN THE BODY OF THIS MANUAL.

CAUTION/WARNING	TEXT PAGE
WARNING	
LETHAL VOLTAGES UP TO 15 KV ARE PRESENT WHEN POWER IS APPLIED TO THE SYSTEM. BE EXTREMELY CAREFUL WHEN WORKING INSIDE THE UNIT. USE ONLY ONE HAND TO MAKE MEASUREMENTS OR ADJUSTMENTS. IF POSSIBLE, TURN POWER OFF BEFORE MAKING ADJUSTMENTS. DO NOT ATTEMPT TO REPAIR OR TROUBLESHOOT THIS UNIT UNLESS YOU HAVE HAD EXPERIENCE IN SERVICING BOTH MICROWAVE AND HIGH VOLTAGE SYSTEMS.	2-10 6-1 6-40
CAUTION	
DO NOT OVERTIGHTEN, AS THIS COULD STRIP THE THREADS OF THE MATING FLANGE.	3-4
CAUTION	
OPERATING THE TWTA WITH UNTERMINATED OR EXCESSIVE LOAD VSWR COULD CAUSE DESTRUCTION OF THE TWT AND WILL VOID THE WARRANTY. THE MAXIMUM LOAD VSWR SHOULD NOT EXCEED 1.5:1.	3-4

CAUTION/WARNING	TEXT PAGE
WARNING LETHAL VOLTAGES UP TO 15 KV ARE PRESENT IN THE POWER AMPLIFIER WHEN IT IS OPERATING. USE EXTREME CAUTION WHEN WORKING INSIDE THE UNIT. AS AN ADDED PRECUATION, IT IS RECOMMENDED THAT ANOTHER PERSON BE PRESENT TO GIVE AID IN CASE OF ACCIDENT.	4-3
CAUTION FAILURE TO OBSERVE ANY OF THE ABOVE CONDITIONS CAN CAUSE CATASTROPHIC DAMAGE TO THE UNIT AND WILL VOID THE WARRANTY.	4-5
CAUTION PRIOR TO PERFORMING STEP E, CHECK THE TWTA DATA SHEET TO DETERMINE THE PROPER RF DRIVE LEVEL. DO NOT EXCEED THIS LEVEL BY MORE THAN 6 dB. OVER-DRIVE OF THE TWTA COULD CAUSE DAMAGE TO THE EQUIPMENT.	4-5
WARNING TREAT THE OPEN UNIT AS THOUGH HIGH VOLTAGE WAS ON WHENEVER THE COVERS ARE OFF THE UNIT.	6-2
WARNING ANYTIME THE TOP COVER IS OFF, YOU ARE EXPOSED TO 120/230 VAC FROM THE PRIME POWER SOURCE IF THE TWTA IS CONNECTED TO THE PRIME POWER DISTRIBUTION SYSTEM.	6-3
CAUTION PRIOR TO APPLYING POWER TO THE UNIT, VERIFY THAT A SUITABLE LOAD, ADEQUATE TO HANDLE UP TO 400W CW WITHOUT DAMAGE, AND WITH A MAXIMUM VSWR OF 1.5:1 ACROSS THE POWER AMPLIFIER OPERATING RANGE, IS PROVIDED AT ALL TIMES. OPERATION OF THE SYSTEM WITHOUT A SUITABLE LOAD CAN DAMAGE OR DESTROY THE TWT.	6-3

CAUTION/WARNING	TEXT PAGE
WARNING	
TURN ALL POWER OFF BEFORE ATTEMPTING ANY CLEANING OPERATION. WHEN USING SOLVENTS BE SURE TO PROVIDE ADEQUATE VENTILATION AND AVOID BREATHING THE FUMES. WHEN CLEANING WITH AIR, WEAR SAFETY GOGGLES AND USE CLEAN, DRY, COMPRESSED AIR NOT EXCEEDING 25 PSI.	6-6
LETHAL VOLTAGES UP TO 15 KV ARE PRESENT IN THE POWER AMPLIFIER WHEN IT IS OPERATING. USE EXTREME CAUTIONWHEN WORKING INSIDE THE UNIT. AS AN ADDED PRECUATION, IT IS RECOMMENDED THAT ANOTHER PERSON BE PRESENT TO GIVE AID IN CASE OF ACCIDENT. DO NOT ATTEMPT TO SERVICE THE TWTA UNLESS YOU ARE FAMILIAR WITH SAFETY PROCEDURES FOR RF AND HIGH VOLTAGE SERVICING OPERATIONS.	6-10
WARNING	
THE BODY OF THE HIGH VOLTAGE MONITOR WILL BE FLOATING UNLESS THE GROUND LEAD IS PROPERLY ATTACHED. IN ADDITION, ANY VOLTAGE READING MADE WITHOUT USE OF THE GROUND WILL BE SUSPECT.	6-24 6-30
WARNING	
THE MEASUREMENT OF THE CATHODE TO HELIX VOLTAGE EXPOSES THE OPERATOR TO POTENTIAL VOLTAGES AS HIGH AS 15 KV. EXTREME CAUTION MUST BE EXERCISED IN MEASURING THE HIGH VOLTAGE SECTIONS OF THS POWE SUPPLY.	6-29
CAUTION	
DO NOT DISTURB THE LOWER MOUNTING BOLTS OF THE A1 BOARD. THEY DO NOT HAVE TO BE CHANGED OR LOOSENED TO REMOVE THE LOGIC BOARD.	6-41

CAUTION/WARNING	TEXT PAGE
WARNING	
APPLICATION OF 200 VDC TO THE HIGH VOLTAGE MODULE IN A NO-LOAD CONDITION WILL GENERATE A 15 KV OUTPUT. EXTREME CAUTION IS REQUIRED TO AVOID PERSONNEL INJURY.	6-44
WARNING	
THE FOLLOWING PROCEDURES INVOLVE A HIGHER POTENTIAL HAZARD TO PERSONNEL THAN THOSE IN SECTION 6.3.4. VARIAN STRONGLY RECOMMENDS THE USE OF THE VARIAN H.V. MONITOR IF AT ALL POSSIBLE.	6-49
WARNING	
THIS IS A POTENTIALLY RISKY PROCEDURE IF THE H.V. IS TURNED ON FOR ANY REASON. DO NOT TURN ON THE H.V. TAPE THE H.V. CONTROL IN THE OFF/RESET POSITION.	6-50
BE CAREFUL TO AVOID CONTACT WITH THE RFI FILTER ADJACENT TO THE H.V. MODULE BECAUSE IT IS LIVE WITH LINE VOLTAGE POTENTIAL OF 120 OR 230 VAC WHENEVER THE TWTA IS CONNECTED TO THE PRIME POWER DISTRIBUTION SYSTEM.	
WARNING	
THIS PROCEDURE CAN BE RISKY BECAUSE IT INVOLVES OPENING THE H.V. MODULE WHICH GENERTES VOLTAGES TO 15 KV. STAY PHYSICALLY CLEAR OF THE H.V. MODULE AND MAKE SURE EVERYONE ELSE IS CLEAR BEFORE TURNING THE H.V. ON.	6-52
WARNING	
DO NOT CHANGE TAPS AT THIS POINT.	6-54

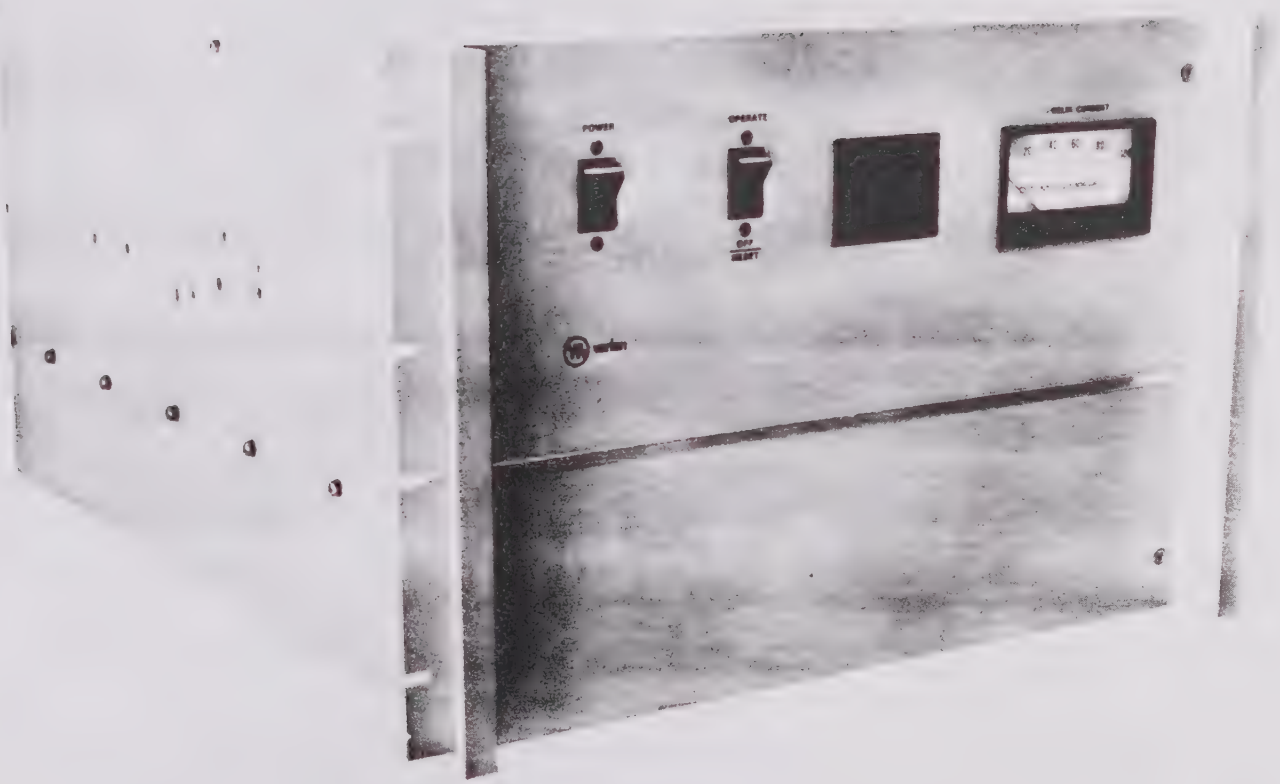

FIGURE 1-1 100/200 WATT GENERAL PURPOSE TRAVELING WAVE TUBE AMPLIFIERS

SECTION 1

INTRODUCTION

1.1 GENERAL

The Varian 100/200W General Purpose 12-1/4" Traveling Wave Tube Amplifiers (TWTAs) are self-contained broad band CW amplifiers that can be used for a variety of applications. This series is based on a standard design that can be configured for operation in the 1-18 GHz range with RF output power levels of 100 to 200 watts.* In addition, a number of options and features are available.

Table 1-1 specifies the configuration for your specific Varian model no. Table 1-2 specifies the electrical performance characteristics. Table 1-3 specifies the mechanical specifications. Table 1-4 summarizes the basic model number designations for different frequency bands and output powers. Table 1-5 summarizes the options and special features that are available.

1.2 PACKAGING

These TWTAs are self-contained units packaged in a single assembly designed for mounting in a standard 19-inch rack. Slide mounts are provided for ease of access. The TWTAs are contained in a 12-1/4" high standard rack mounted drawer, and include integral forced air cooling, power supplies, RF components and control circuitry. The standard configuration provides RF input/output and prime power connections on the Rear Panel.

The unit is modularized for easy service and maintenance.

* Power levels of up to 500 watts are available in certain narrow band applications.

1.3 PRIME POWER

The standard amplifiers are protected by a circuit breaker mounted on the Front Panel. The standard configuration is for 115/230 VAC 50/60 Hz single phase prime power.

1.4 1-20 WATT AMPLIFIERS

The Varian General Purpose TWTA series includes a family of 3½" high rack mount units with RF output power levels in the range of 1-20 watts. These units are the subject of a separate manual. Contact Varian MEO for further details.

TABLE 1-1

VZC-6963G1B CONFIGURATION

	ITEM	QTY	VARIAN PART NO.
1.	TWTA	1	C133600-65
2.	TWT	1	VTC-6262F1
3.	Power Supply	1	STD
4.	Options/Special Features		
	a. Output VSWR Protection		
	b. Type N Input Connector		
	c.		
	d.		
5.	RF Schematic		C134983

TABLE 1-2

ELECTRICAL SPECIFICATIONS OF
100/200 WATT GENERAL PURPOSE 12-1/4" TWTAs

PARAMETER	VALUE
Power Levels	100 or 200 watts CW standard (See Table 1-4)
Frequencies	1-18 GHz (See Table 1-4)
Gain	30-45 dB (See Table 1-4)
Input/Output Impedance	50Ω nominal TWT impedance or waveguide
Noise Figure	40 dB max., 35 dB typical
Power Output Stability	Typical long term 0.25 dB/24 hours at constant drive and constant temperature
Spurious Noise Levels	At least -50 dBc excluding harmonics and residual modulation
Prime Power	115/230 volts ± 10%, 50/60 Hz, single phase
Residual AM & PM Noise	At least -45 dBc. Typically better than -55 dBc.

TABLE 1-3

MECHANICAL/ENVIRONMENTAL SPECIFICATIONS OF
100/200 WATT GENERAL PURPOSE 12-1/4" TWTA SERIES

PARAMETER	VALUE
Size (H x D x W)	Height 12-1/4" (31 cm) x length 24" (61 cm) behind front panel excluding connectors x width 19" (48 cm).
Weight (Range)	240 lbs. typical, 275 lbs. max.
Temperature Range	0 - +50°C standard operation. All metal ceramic tubes rated for high reliability in military environments typically -54°C to +110°C.

TABLE 1-4

STANDARD MODELS

100/200 WATT GENERAL PURPOSE 12-1/4"

TRAVELING WAVE TUBE AMPLIFIER SERIES

TWTA MODEL NUMBER	FREQUENCY GHz	POWER WATTS	GAIN AT RATED POWER (dB)	INPUT RF CONN.	OUTPUT RF CONN.	TUBE TYPE
VZL-6942G1	1 - 2	100	30	SMA	TYPE N	VTL-6240F1
VZL-6943G1	1 - 2	200	30	SMA	TYPE N	VTL-6242F1
VZS-6952G1	2.0-4.0	100	40	SMA	TYPE N	VTS-6250F1
VZS-6953G1	2.0-4.0	200	37	SMA	TYPE N	VTS-6252F1
VZG-6953G2	2.6-5.2	200	45	SMA	TYPE N	VTG-6232F1
VZC-6962G1	4.0-8.0	100	35	SMA	TYPE N	VTC-6260F1
VZC-6963G1	4.0-8.0	200	37	SMA	TYPE N	VTC-6262F1
VZJ-6963G2	4.8-9.6	200	40	SMA	WRD475D24	VTJ-6264F1
VZH-6972G1	7.0-11.0	100	40	SMA	TYPE N	VTH-6270F1
VZH-6973G1	7.0-11.0	200	35	SMA	UG-1493/U	VTH-6272F1
VZX-6982G1	8.0-12.4	100	40	SMA	UG-39/U	VTX-6280F1
VZX-6983G1	8.0-12.4	200	35	SMA	UG-39/U	VTX-6282F1
VZU-6992G1	12.4-18.0	100	37	SMA	UG-419/U	VTU-6290F1
VZU-6992G2	9.0-17.0	100	37	SMA	WRD750D24	VTU-6295F1

TABLE 1-5

AVAILABLE OPTIONS AND SPECIAL FEATURES
VARIAN GENERAL PURPOSE WIDE BAND TWTAs

AMPLIFIER CHARACTERISTIC	DESCRIPTION
Performance	. Optimized power and gain over non-standard frequency ranges. . More stringent environmental performance . Serrodyne operation for most of the models.
Input/Output Connectors	. Non-standard RF connector types . Front Panel location
RF Components	. 40 dB RF output sample port . Input RF Attenuator . Gain Equalizers . Input and Output Isolators . Harmonic Filters . VSWR protection . Solid State Drivers . Remote TWT location with mating connector. . Pin Diode RF Input Switch.
Controls/Meters	. Remote Control . Elapsed Time Meter (front panel)
Prime Power	. 115/230 VAC single phase 47-420 Hz

SECTION 2

FUNCTIONAL DESCRIPTION

2.1 GENERAL

The general purpose wide band TWTAs are designed for simple and reliable operation. They are self-protecting against damage from most internal fault conditions. Typically, octave frequency bands are covered without need for tuning or operator adjustment. The units include proportional heater time delay as a standard feature. Once placed into operation the TWTA will recycle back into operation automatically after prime power interruptions. The TWTAs are functionally divided into four sections. These sections are: Front Panel, Rear Panel, Power Supply and RF Sections.

2.2 FRONT PANEL

The Front Panel of the Power Amplifier is the primary operator interface with the TWTA and provides the necessary controls and indicators to permit control and monitoring of the TWTA. Refer to Figure 2-1 for a photo of the standard Front Panel.

2.2.1 Status Indicator

The Status Indicator display (annunciator) is located in the top center of the TWTA Front Panel. Standard indications provided are: power on, filament time delay, standby, high voltage on, summary fault, cover interlock fault, helix current fault, TWT overtemperature fault, external interlock fault, remote control fault, reflected power fault and power supply fault.

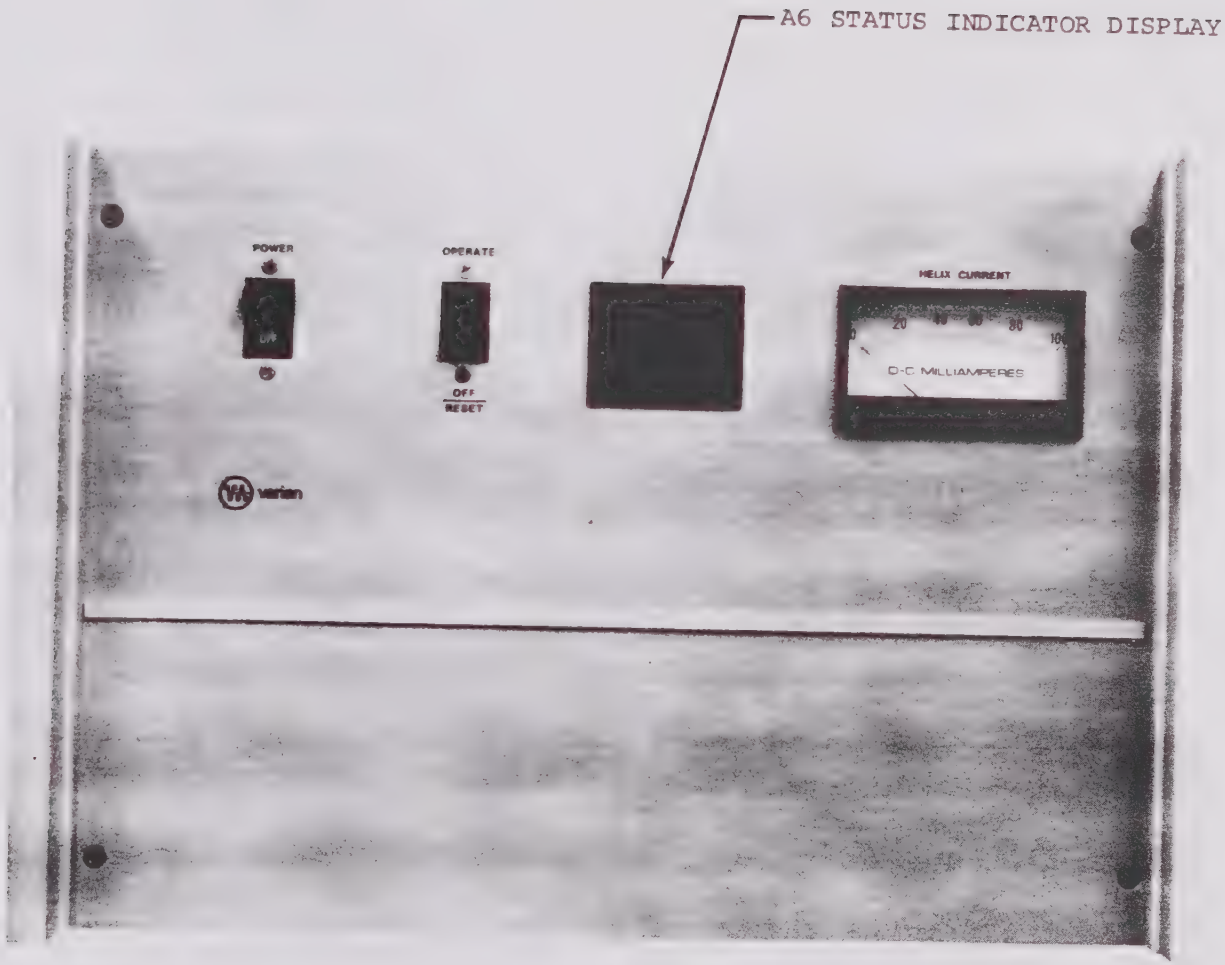

FIGURE 2-1 100/200 WATT GENERAL PURPOSE WIDE BAND TWTA
STANDARD FRONT PANEL A5

a. POWER ON

When the power on/off control of the TWTA is turned to the "ON" position. The logo will light red to indicate this condition.

b. TIME DELAY

The Time Delay indicator is lit when the TWTA is initially turned on or after a short prime power failure. The indication advises that the TWT filaments are in the process of heating. The heating time is three minutes maximum. The filament time delay circuitry is proportionally consistent with tube requirements. Thus in the event of a power failure, the length of time delay will be proportional to the length of the power failure.

c. STANDBY

The standby condition indicates that the filament time delay is complete, no TWTA faults are registered and the high voltage can be turned on. It is also an indication that the delay is over, no faults exist and the H.V. is off.

d. BEAM ON

The Beam On indicator registers when the OPERATE switch is set to ON indicating that helix and collector voltages are applied to the TWT and no fault condition exists.

e. FAULT

The Fault indicator registers any time a major fault occurs. The faults monitored in the TWTA are: helix overcurrent, TWT overtemperature, cover interlock and various power supply faults. Any one of the above faults will cause the high voltage to turn off. This indicator is latching and will stay latched until reset.

2.2.2 Control Switches

Two controls are provided on the TWTA. They are the POWER On/Off Circuit Breaker and the OPERATE/OFF/RESET switch.

The Power ON/Off Circuit Breaker controls prime power application to the internal circuitry. It also provides prime power overcurrent protection for the amplifier. The OPERATE/OFF/RESET Switch turns the high voltage on or off. This switch in the OFF/RESET position also resets some common faults and fault indicators. Some faults can only be reset when the POWER Circuit Breaker is set to OFF.

2.2.3 Helix Current Meter

The HELIX CURRENT Meter provides an analog indication of the TWT helix current. The meter is calibrated in milliamperes.

2.3 REAR PANEL

The Rear Panel of the TWTA contains various interface points that are required during initial installation or service. Refer to Figure 2-2 for a photo of the Rear Panel.

2.3.1 RF Input

On the standard amplifier the RF INPUT signal is applied through the type SMA female connector located on the Rear Panel. As an option, the RF Input can be located on the Front Panel instead of the Rear Panel without changing its function.

2.3.2 RF Output

The RF Output for the TWTA is either waveguide or type N female depending on amplifier model. Refer to Table 1-4.

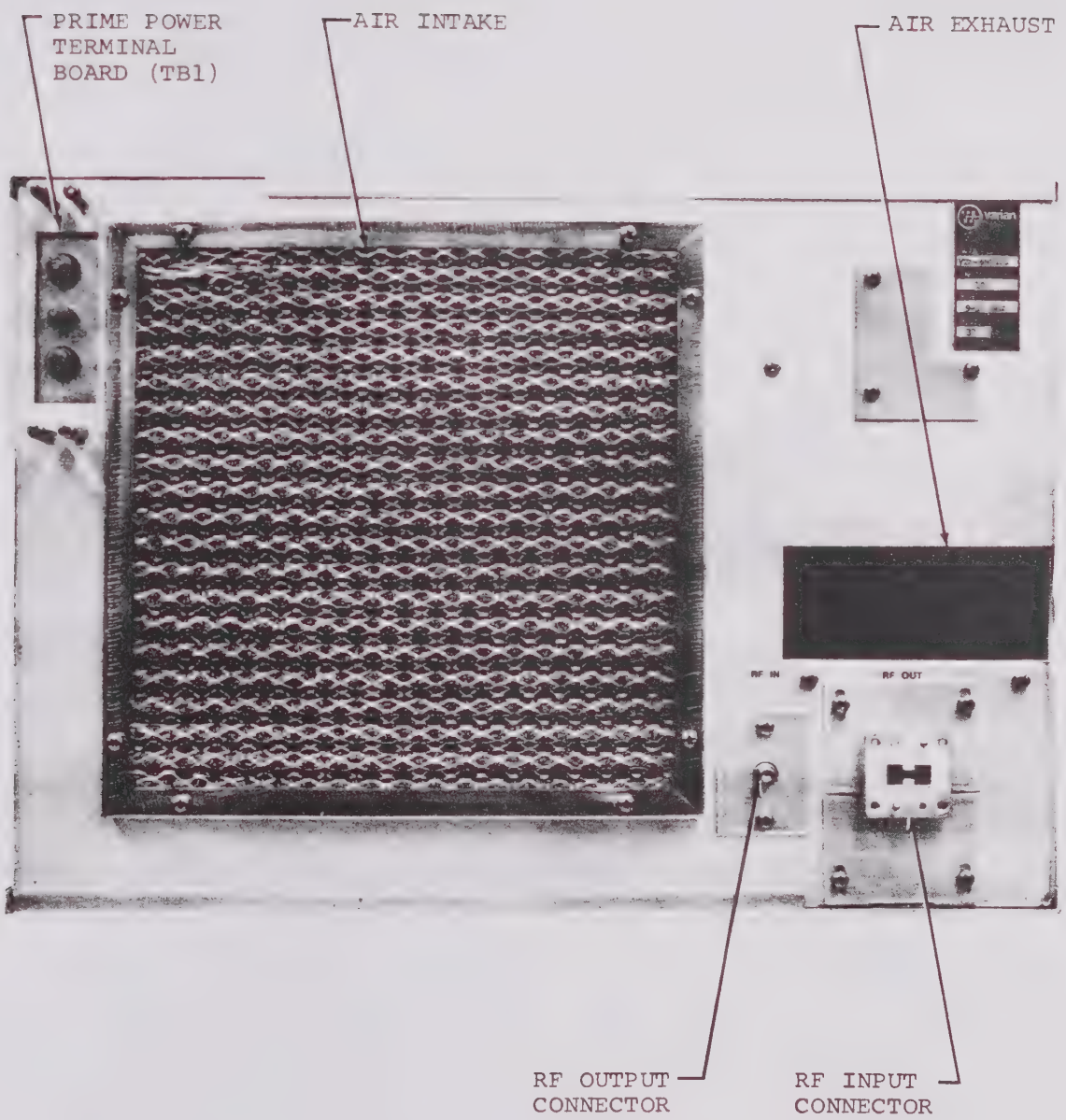

FIGURE 2-2 100/200 WATT GENERAL PURPOSE WIDE BAND TWTA STANDARD REAR PANEL

2.3.3 Air Intake Exhaust

Forced air for cooling of the TWTA is provided by an internal blower. Both the air intake and the air exhaust ports are located on the Rear Panel. Referring to Figure 2-2, the cooler air enters the TWTA on the left side and exhausts as hotter air on the right side.

2.3.4 Prime Power Connections

The prime power input is applied to the TWTA at TB1 on the Rear Panel.

2.3.5 Remote Interface (Optional)

A Remote Interface Connector (J2) and Switch can be provided. This permits remote control and status monitoring of the TWTA.

2.4 POWER SUPPLY SECTION

2.4.1 General

The Power Supply is based on a modular design derived from Varian experience with ground station communication system TWTAs. A block diagram of the Power Supply is presented in Figure 2-3. This unit provides the sequential commands, interfaces, protection circuits and voltages required for operation of the TWTAs. The standard Power Supply is located in the upper portion of the TWTA Assembly (see Figure 2-4) and consists of six printed circuit cards, a High Voltage Module and chassis mounted components. Functionally it can be divided into six parts.

2.4.2 Logic PWB Assembly A1

The logic board contains the logic functions necessary to control and sense amplifier conditions and drive the Status Indicator Displays on the Front Panel. This board also monitors fault status, provides for proportional time delay, and controls the application of collector and helix voltage.

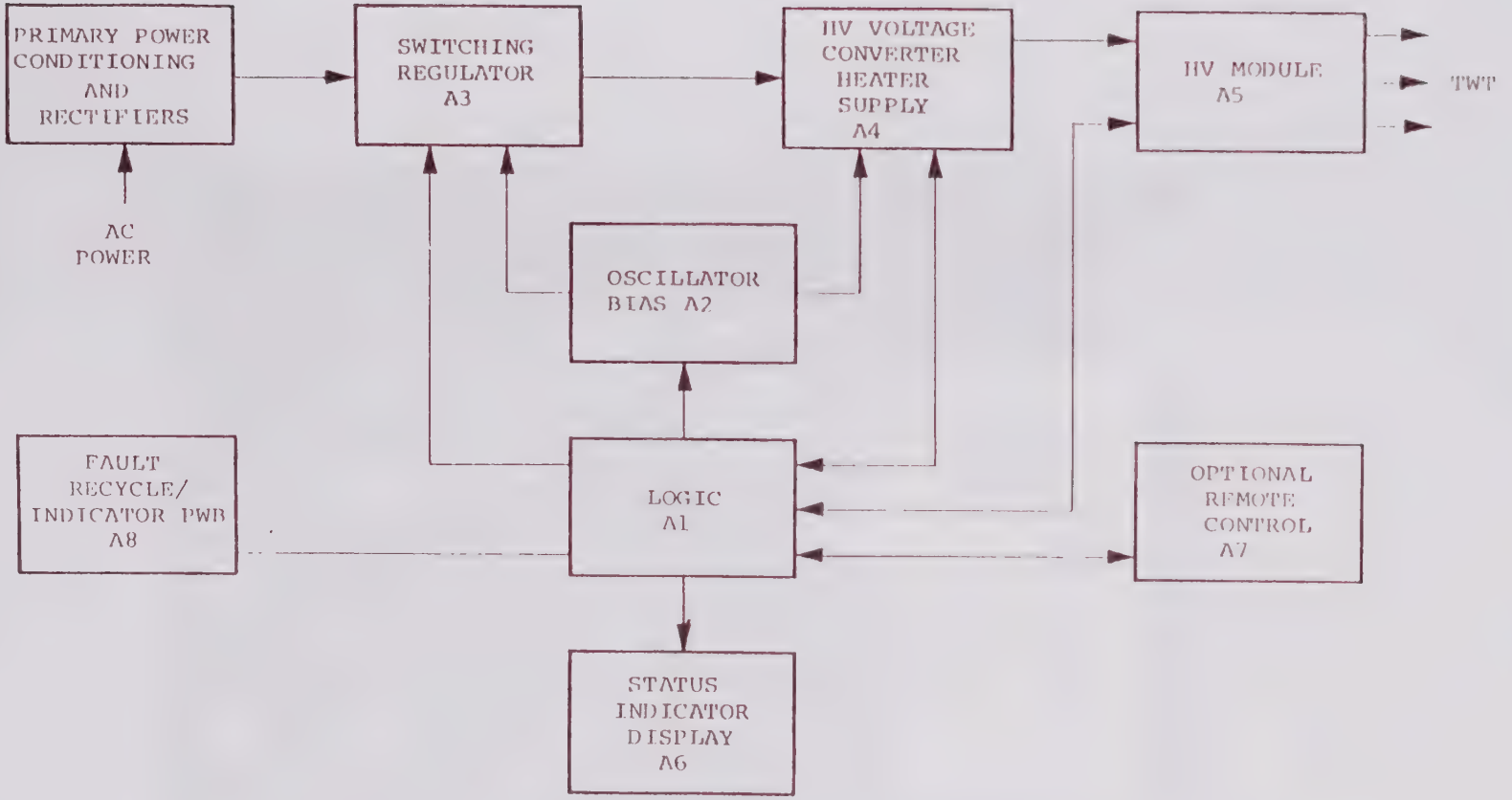

FIGURE 2-3 POWER SUPPLY BLOCK DIAGRAM

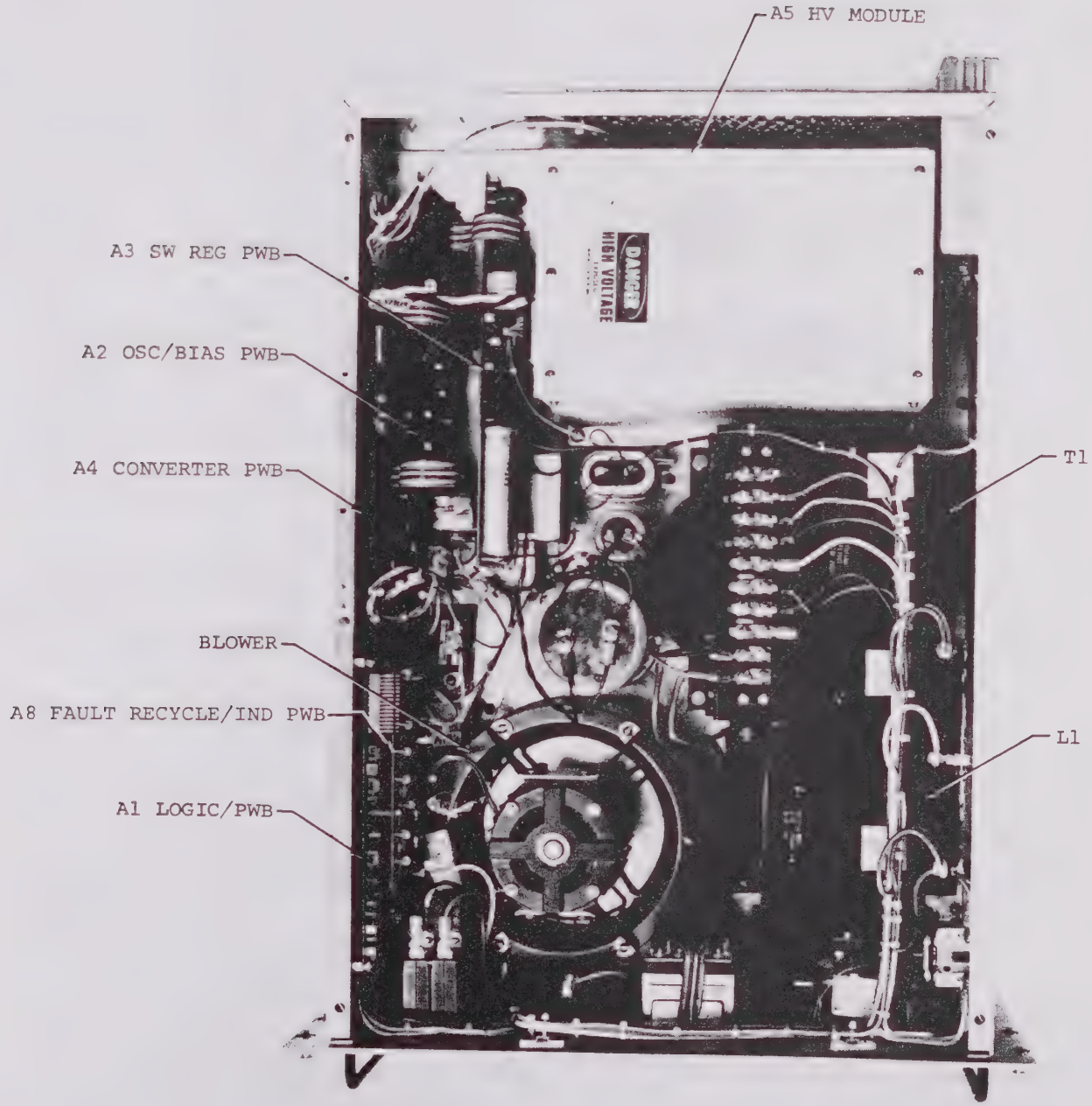

FIGURE 2-4 TOP VIEW GENERAL PURPOSE WIDE BAND TWTA

2.4.3 Oscillator Bias PWB Assembly A2

The Oscillator Bias board contains a number of circuits. The first of these is a 10 KHz oscillator. This supplies base drive current to the high voltage converter and also synchronizes the switch regulator. Voltages of +12, +5, -5, -15 and -30 VDC are generated on this board. It also contains sense circuitry and latches for a number of protection functions such as 250V over/under voltage, 200V over/under voltage, 38V over/under voltage. The protective circuits outputs are summed together in a common summary fault line which is an output to the logic control board.

2.4.4 Switch Regulator PWB Assembly A3

The Switch Regulator board regulates a 200 VDC buss that feeds the High Voltage Converter which in turn feeds the High Voltage Module and the TWT. A sample of the Helix HV output is fed back to the Switch Regulator. This allows close regulation of the total TWT helix and collector voltages.

The Switch Regulator is self-protected against any combination of over/under voltage and short circuit conditions and is the primary line/load regulating element in the Power Supply.

2.4.5 High Voltage Converter/Heater Supply Assembly A4

The High Voltage Converter board is a bridge circuit providing a 10 KHz, 150-200 VDC square wave to the High Voltage Module. This assembly also contains its own over-current protection and a TWT heater regulator.

2.4.6 High Voltage Module A5

The high Voltage Module is a separate field replaceable item containing the high voltage transformer, heater transformer, rectifiers and filters for all TWT voltages, helix voltage and current sense resistors. The 200 VAC square wave from the high voltage converter is fed to the

high voltage transformer. The voltage is then transformed to the high voltage levels necessary to drive the TWT. The collector voltage is depressed from that of the helix voltage to optimize the overall amplifier efficiency. Two printed circuit boards are used.

2.4.7 Power Conditioning Circuits

The input power circuitry contains an EMI filter, power transformer, circuit breaker, input bridge rectifier and filters. It provides for complete isolation of the power supply from the input line voltage and minimizes susceptibility to external interferences. An additional feature is the use of SCRs in the input bridge which allow for fast shutdown in the event of over-voltage conditions. During normal operation, the SCRs function only as diodes. Output of this section is approximately 250 VDC.

****

WARNING

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LETHAL VOLTAGES UP TO 15 KV ARE PRESENT WHEN POWER IS APPLIED TO THE SYSTEM. BE EXTREMELY CAREFUL WHEN WORKING INSIDE THE UNIT. USE ONLY ONE HAND TO MAKE MEASUREMENTS OR ADJUSTMENTS. IF POSSIBLE, TURN POWER OFF BEFORE MAKING ADJUSTMENTS. DO NOT ATTEMPT TO REPAIR OR TROUBLESHOOT THIS UNIT UNLESS YOU HAVE HAD EXPERIENCE IS SERVICING BOTH MICROWAVE AND HIGH VOLTAGE SYSTEMS.

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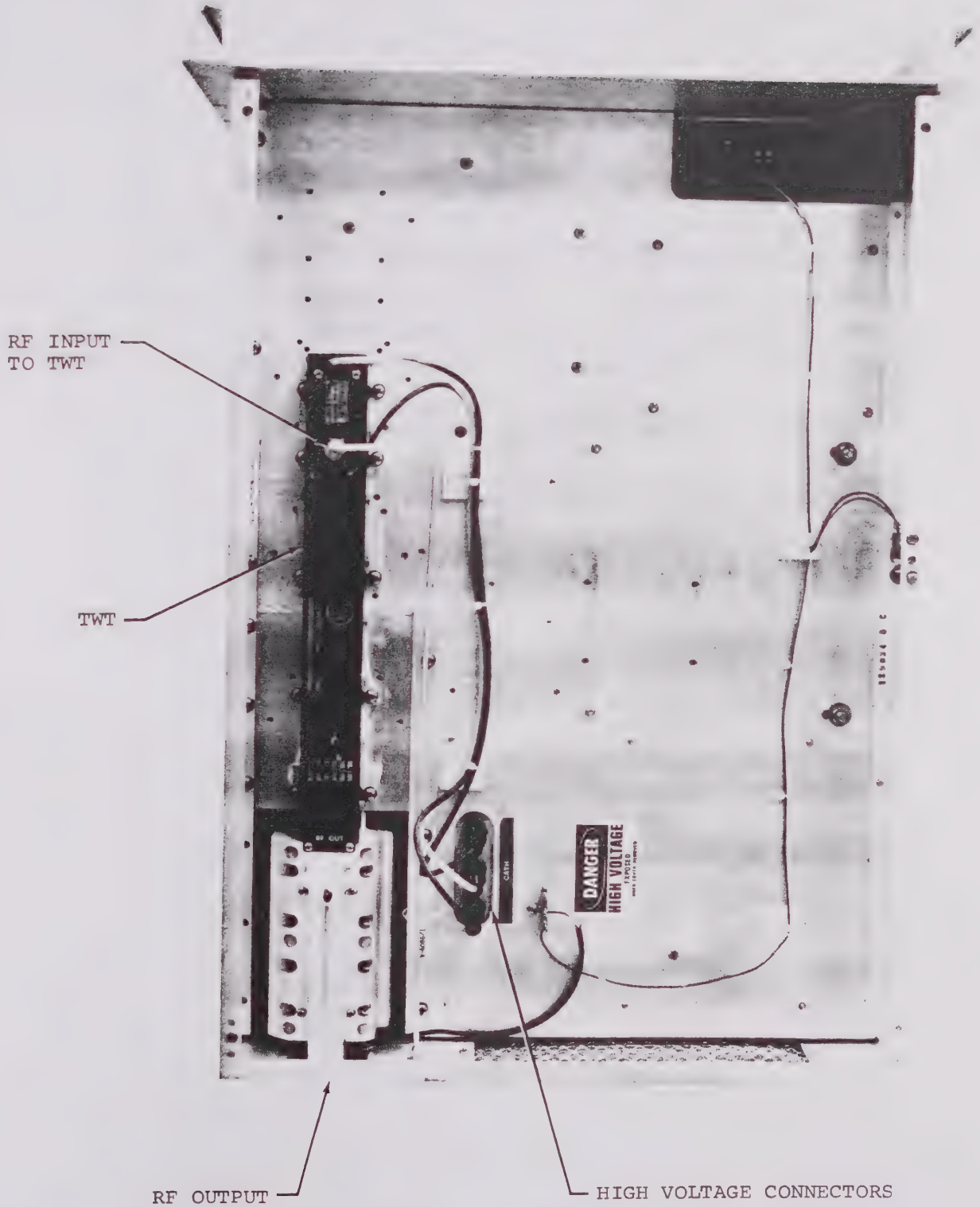
2.5 RF SECTION

The RF Section is located in the bottom portion of the TWTA (See Figure 2-5).



BOTTOM VIEW TWTA

FIGURE 2-5 LOCATION OF RF SECTION

The standard configuration includes a TWT, RF input and output cables, and integral forced air cooling for the TWT. The RF output of the TWTA is a function of the specific configuration selected. RF gain varies from 30 to 40 dB for the 100 watt versions and from 30 to 45 dB for the 200 watt versions (see Table 1-4).

The RF section has been designed to accommodate a wide variety of RF configurations from a single TWT with input/output connectors to a sophisticated unit that includes solid state preamplifier, VSWR protection detectors, RF power meter, isolators, couplers and filters. See Table 1-5 for some of the options that are available. Additional special features can also be included upon request.

SECTION 3

UNPACKING AND INSTALLATION

3.1 UNPACKING

3.1.1 Pre-Inspection

Prior to unpacking, inspect the exterior of the packing containers for evidence of damage in shipment. If damage seems evident, immediately contact the carrier that delivered the unit and submit a damage report. Failure to do so could invalidate future claims.

3.1.2 Unpacking

Carefully unpack and remove all items. Save all packing material until all inspections are complete. It is recommended that all packing material be saved for potential future use.

NOTE

File the TWTA Test Date Sheets received with the equipment in a convenient place. They will be needed for some of the maintenance adjustment procedures.

3.1.3 Check Packing Slips

Verify that all items listed on the packing slips have been received.

3.1.4 Post-Unpacking Inspection

Inspect all items for evidence of damage in shipment. If damage seems evident, immediately contact the carrier that delivered the equipment and file a claim. Failure to do so could invalidate future claims.

Check the unit thoroughly for damaged or loose parts. To remove the top cover, unscrew the five screws one-quarter turn and lift the cover off. After visual inspection is complete, reinstall the cover and tighten all screws.

3.1.5 Pre-Installation Electrical Inspection

A preliminary electrical inspection can be performed at this time. However, due to the complexity of interconnection, it is advised that electrical inspection be performed after installation of the equipment in its final rack assembly. If it is desired to conduct an electrical inspection prior to installation in the final rack assembly, refer to sections 3.2, 3.3 and 4.3 for procedures and verifications. The following basic steps must be completed.

a. Verify a proper termination on the input and output of the TWTA.
b. Verify proper AC prime power connections to the TWTA.
c. Follow the initial turn-on procedures as detailed in section 4.3.

3.2 MECHANICAL INSTALLATION

The following procedures should be followed for installation of the TWTA into the final rack assembly.

3.2.1 Rack Installation

The TWTA is designed for rack slide mounting in a standard 19-inch wide rack cabinet. The following procedures should be followed:

a. Locate the rack position which is to contain the TWTA.

b. Mount the mating slides (supplied) to the rack cabinet. Refer to the outline drawings on the TWTA included in Section 7 of this manual for exact dimensioning of the rack slide center lines with relation to the unit Front Panel.

c. Install the TWTA on the mating slides and securely fasten the Front Panel to the rack cabinet rails. Use proper handling equipment such as a forklift for this task.

d. Once the unit is installed on the slides and fastened to the cabinet, the balance of the installation procedures can be completed.

3.2.2 Waveguide Connection

This section applies only to those models with waveguide connectors. Refer to Table 1-1.

The output waveguide flange of the TWTA is located on the Rear Panel of the TWTA. Refer to the outline drawing of the TWTA located in Section 7 of this manual for exact dimensioning of the waveguide flange. Proceed as follows:

a. Adjust the interconnecting waveguide so that the interconnecting waveguide aligns precisely with the waveguide flange at the rear of the TWTA.

b. If alignment is not precise, or if the installation is subject to motion or vibration, a flexible waveguide section should be installed between the output of the TWTA and the interconnecting waveguide.

c. After alignment is verified in all three planes, bolt the interconnecting waveguide to the output waveguide flange of the TWTA. Start all bolts to verify proper alignment prior to tightening any bolts.

d. Tighten all bolts so that the connection is firm, tightening bolts across the waveguide flanges rather than in order around the perimeter of the flange.

CAUTION

Do not overtighten, as this could strip the threads of the mating flange.

e. If it is desired to pressurize the interconnecting waveguide, it is suggested that a pressure window be installed at the output of the TWTA.

CAUTION

Operating the TWTA with unterminated or excessive load VSWR could cause destruction of the TWT and will void the warranty. The maximum load VSWR should not exceed 1.5:1.

3.2.3 Air Ducting

The TWTA is forced air cooled. The exhaust air from the TWTA may be at a relatively high temperature and heat dissipation may be as high as 2000W. In order to prevent heat buildup in the rack cabinet, it is advisable that the exhaust air be ducted away from the TWTA and outside of the rack cabinet. Particular care must be taken to assure that exhaust air cannot recirculate to the amplifier air intake area. If exhaust ducting is not used, a minimum of eight inches of free space should be left at the rear of the TWTA exhaust port. Suitable cabinet louvers or ventilation must be provided along with high volume cabinet blowers. If exhaust ducting is to be provided, the external ducting must have a cross sectional area at least equal to that of the exhaust opening. Exhaust duct bends and transitions must be smooth and bend radii should be as large as possible.

3.3 ELECTRICAL INTERCONNECTION

Electrical interconnections to the system consist of prime power and ground connections.

3.3.1 AC Prime Power

Prime power requirements for the subsystem is nominal 115/230 VAC, 50-60 Hz. Prime power must be single phase, 3 wire, with the third wire earth ground. The wiring for 230 VAC prime power is shown in Figure 3-1. Wire used for applying prime power to the system should be 12 gage min. as defined by UL 817. Power is applied to barrier terminal strip TB1 located on the Rear Panel of the TWTA. The terminal strip is designed for terminal lugs using #10 screw terminals. Prime power is applied to terminals 1 and 2 of the TB and the earth ground wire is supplied to terminal 3 of the TB (see Figure 2-2).

3.3.2 Grounding

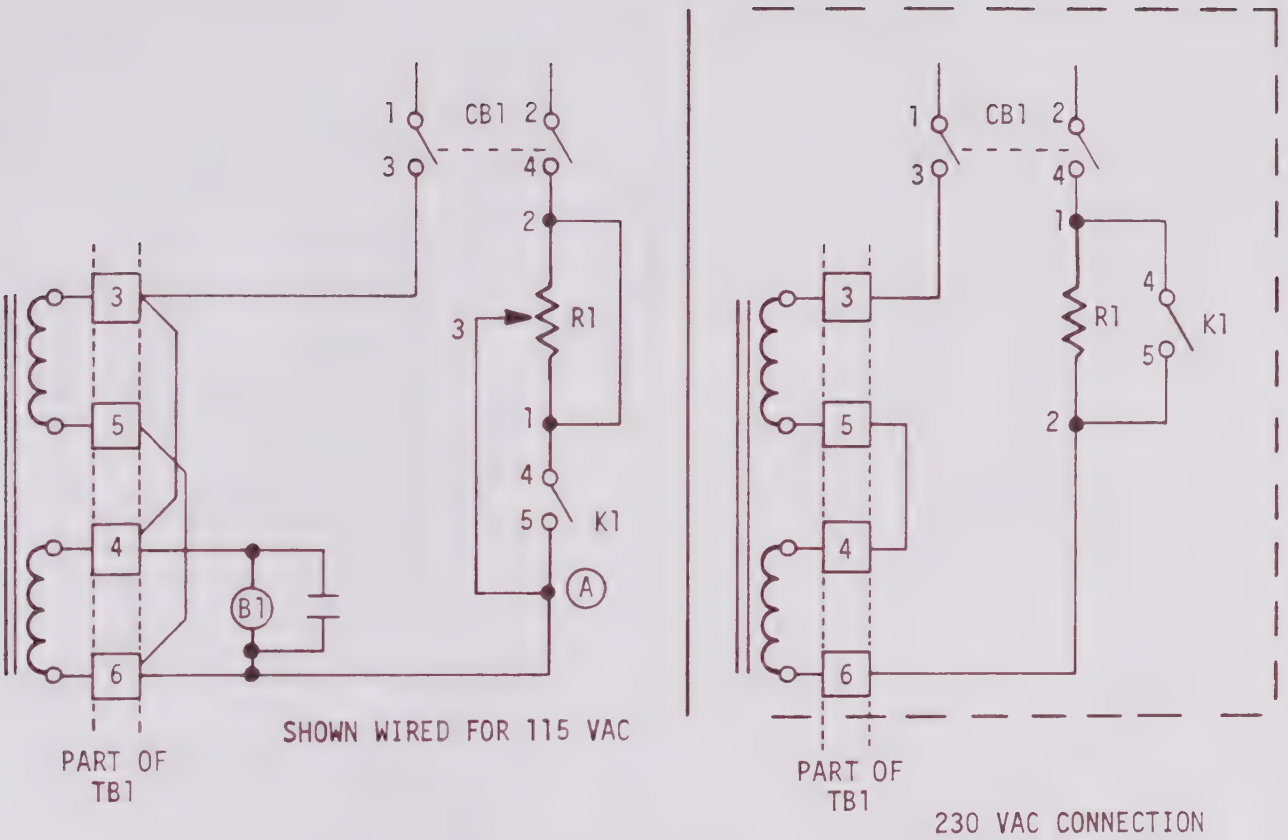
It is necessary for personnel and equipment safety to securely ground the amplifier to earth ground. The ground connection is located on the rear of the TWTA. This should be securely connected to prime power ground and tied to a ground bus tie point in the rack cabinet assembly.

3.3.3 External Connections

The Remote Control Interface connector provides an interface between the TWTA and remotely located customer status indicators and controls. As shown in Figure 3-2, remote status indicators can be actuated through relay contacts on J3-2,3,4; J3-5-6,7, J3-8,5,10 and J3-11,12, 13. High Voltage can be remotely controlled by a switch between J3-16 and J3-21.

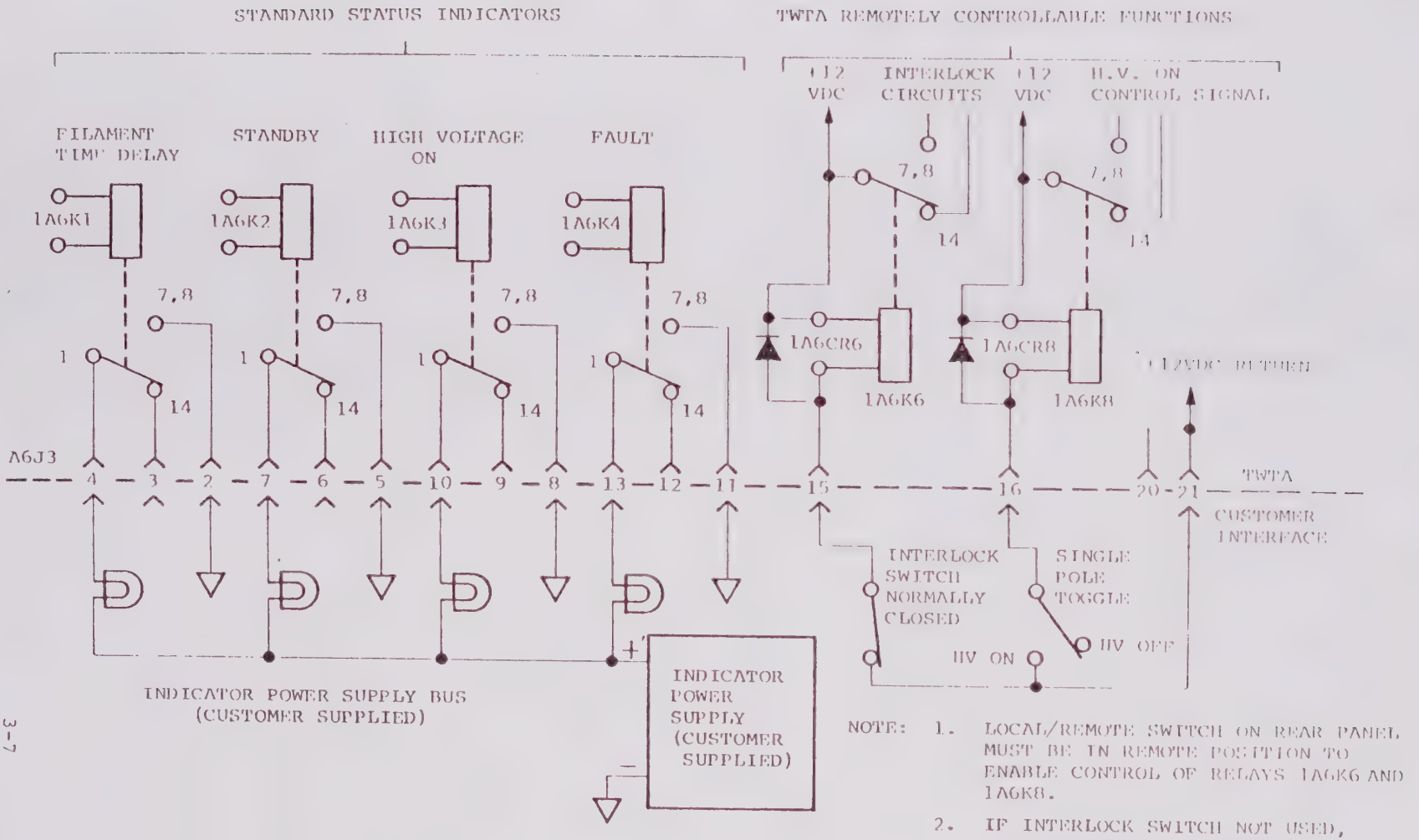
NOTE

Either a jumper or a normally closed remote interlock switch must be installed between J3-15 and J3-20.



LINE VOLTAGE	CONNECTIONS	
	TRANSFORMER T1	RESISTOR R1
115 VAC	REMOVE JUMPER 4, 5 PUT JUMPERS BETWEEN 3 AND 4 AND BETWEEN 5 AND 6.	WIPER (R1-3) CONNECTED TO POINT A. JUMPER BETWEEN R1-1 AND R1-2.
TO CONVERT TO 230 VAC	REMOVE JUMPERS BETWEEN 3-4, 5-6, REPLACE WITH JUMPER FROM 5 TO 4.	MOVE WHITE WIRE CONNECTION FROM R1-3 (WIPER) TO R1-2. REMOVE JUMPER BETWEEN R1-1 AND R1-2. TRANSFER RED WIRE (CB1-1B) FROM R1-2 TO R1-1.

FIGURE 3-1. VOLT CONNECTIONS



NOTE: 1. LOCAL/REMOTE SWITCH ON REAR PANEL MUST BE IN REMOTE POSITION TO ENABLE CONTROL OF RELAYS 1A6K6 AND 1A6K8.

2. IF INTERLOCK SWITCH NOT USED, CONNECT A JUMPER BETWEEN 1A6J3-15 AND 1A6J3-20.

FIGURE 3-2 TYPICAL REMOTE CONTROL INTERFACE CONNECTION

3.4 REPACKAGING FOR SHIPMENT

The instructions given below are intended as a general guide for repackaging the TWT amplifier system for shipment. A detailed discussion on returning goods can be found on the back of the warranty sheet at the rear of this manual. If you have any questions, contact the Varian field office in your area for assistance.

3.4.1 Shipping Container

Place the system in the original shipping container, making sure that there is adequate packing material around all sides of the system and that the front panels are protected with thick cardboard strips. If you do not have the original container, use heavy wooden boxes with adequate protection.

3.4.2 Sealing Container

Seal the shipping containers with nails or metal bands.

3.4.3 Marking

Write the words "Fragile", "Delicate Instrument", etc. in several places on the outside of the shipping container.

NOTE

If the system is to be shipped to Varian for service or repair, attach to it a tag identifying the owner. Also indicate the service or repair desired, the problems encountered and any other information that would be of value to the service facility.

In all correspondence refer to the unit by both the model and serial numbers.

Please use the following shipping address for all returned products:

VARIAN ASSOCIATES
Microwave Components and Subsystems Division
3200 Patrick Henry Drive
Santa Clara, California 95054
Atten: Customer Support

SECTION 4

OPERATION

4.1 GENERAL

This section describes the normal operation of the Varian General Purpose Wide Band TWTAs. The operating modes, the controls indicators and meters, and the turn-on turn-off procedures will be discussed. All controls used in normal operation are located on the Front Panel of the TWTA. Status and fault indicators provide displays of status of the unit at all times.

4.2 OPERATING MODES

There are four operating modes for the unit. The modes are: Time Delay, Standby, Beam On and Fault.

4.2.1 TIME DELAY

In this mode, indicated when the TIME DELAY indicator is lit, the power supply is providing only heater power to the TWT. The helix and the collector voltages are inhibited during the time delay phase. The power supply enters this mode immediately when the power is switched to ON and remains in this mode for approximately 3 minutes to allow the TWT heater to reach its proper operating temperature. The STANDBY or BEAM ON indicator will then light depending on the position of the OPERATE/OFF/RESET switch.

The time delay circuitry provides for proportional time delay in the event that a prime power failure occurs. If the OPERATE/OFF/RESET switch is in the OPERATE condition and a prime power failure occurs, then when prime power is restored, the TWTA will cycle in a time delay proportional to the length of time of the power failure. The high

voltage will then automatically turn itself on after time delay. If the high voltage is in the OFF condition at a power failure, then the TWTA will cycle in time delay proportional to the power failure and stop in a STANDBY mode.

4.2.2 STANDBY

This mode is indicated by only the STANDBY indicator being lit. In this mode, only filament voltage is applied to the TWT and high voltage can be applied by pressing the operate switch. Standby is defined as no filament time delay, high voltage off and no faults existing.

4.2.3 BEAM ON-High Voltage On

The BEAM ON indicator lights whenever the OPERATE/OFF/RESET switch has been ser to OPERATE and high voltage is on, i.e., the collector and helix voltages are applied to the TWT.

4.2.4 FAULT

The Fault mode is indicated by the FAULT indicator being lit. The FAULT indicator is a summary alarm. The following faults cause the FAULT indicator to light: high helix current; TWT overtemperature; internal interlock, undervoltage for -200V, -200V overvoltage and HV converter overcurrent. The FAULT indicator also indicates a lockout condition. The OPERATE/OFF/RESET switch must be ser to OFF/RESET to reset the fault and then set to OPERATE again to enter a BEAM ON condition. On early units (S/N 101-104) some power supply faults can only be reset by turning off main power. These are -200V under or overvoltage and converter overcurrent.

****

WARNING

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LETHAL VOLTAGES UP TO 15KV ARE PRESENT IN THE POWER AMPLIFIER WHEN IT IS OPERATING. USE EXTREME CAUTION WHEN WORKING INSIDE THE UNIT. AS AN ADDED PRECAUTION IT IS RECOMMENDED THAT ANOTHER PERSON BE PRESENT TO GIVE AID IN CASE OF ACCIDENT.

****

4.3 METERS CONTROLS AND INDICATORS

Figure 4-1 is a photograph of the Front Panel of the standard TWTA.

4.4 INITIAL TURN-ON

Initial Turn-On differs from normal turn-on in that certain precautions must be taken to protect the Power Amplifier against damage from unknown conditions. Once proper overall operation is verified in the final installation, turn-on and turn-off can be accomplished as described in subsequent sections.

4.4.1 Pre-Power Check

Prior to applying prime power to the system, verify that the following conditions are met:

a. Available prime power voltage is within the ratings of the amplifier and that the interconnections in the amplifier have been made for the appropriate input voltage.
b. The output is terminated in a load capable of dissipating the rated CW power or more at the intended operating frequency.
c. The load VSWR over the rated frequency range is less than 1.5:1.

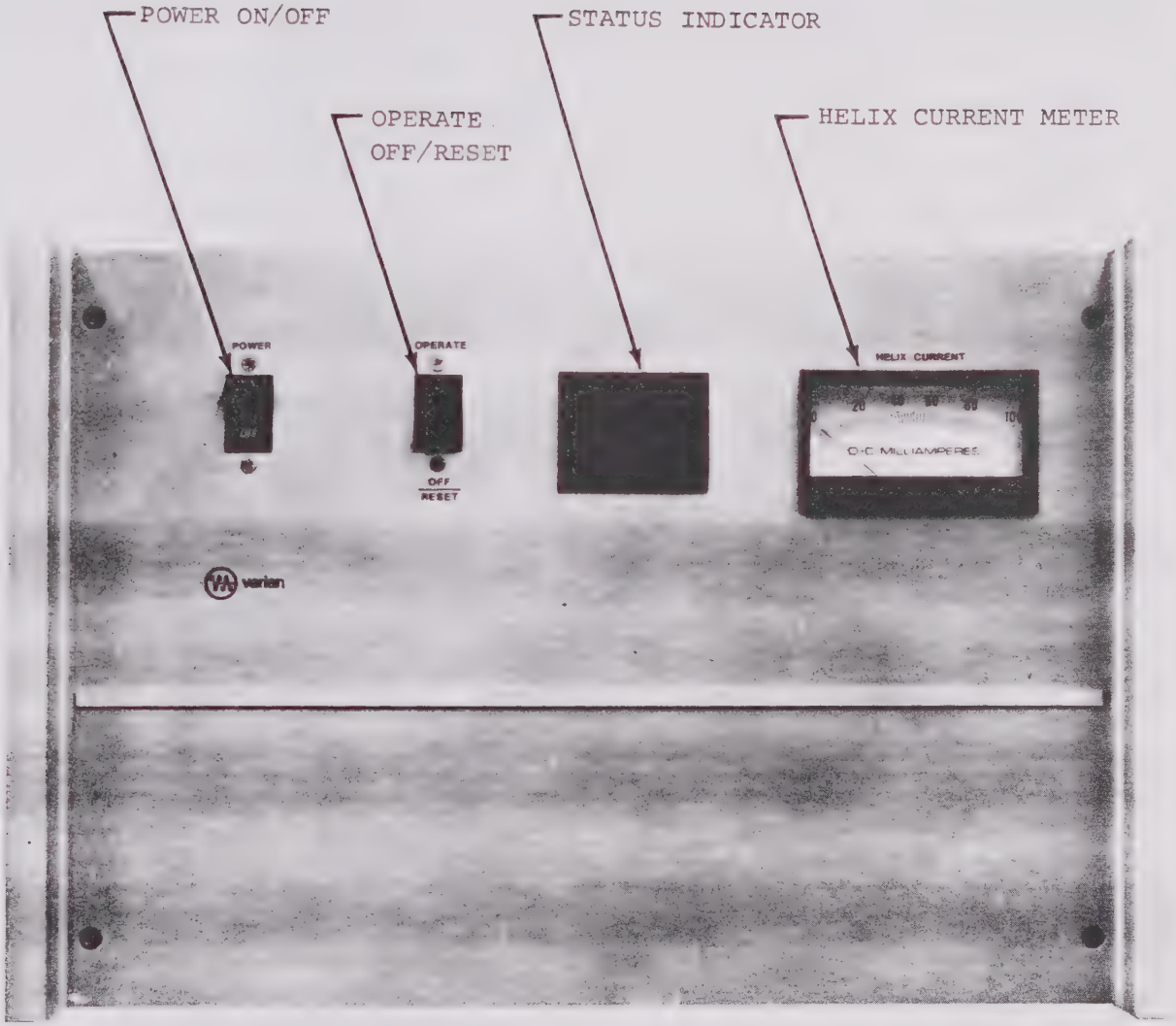


FIGURE 4-1 FRONT PANEL CONTROLS/INDICATORS

d. The RF drive source frequency falls within the rated frequency range and has a level that will now allow excessive overdrive.

e. The rear exhaust air duct and air intake duct from the TWT assembly are not blocked.

CAUTION

Failure to observe any of the above conditions can cause catastrophic damage to the unit and will void the warranty.

4.4.2 Turn-On Sequence

a. Set the input power level to minimum output level.

b. Place the Power Switch in the ON position. Verify that the (VA) LOGO indicator illuminates. Verify that the TIME DELAY indicator is illuminated. No readings should be obtained on the helix current meter at this time.

c. Approximately 3 minutes after power is applied, the TIME DELAY indicator should extinguish, and the STANDBY indicator should immuminate.

d. Set the OPERATE/OFF/RESET switch to OPERATE. Verify that the STANDBY indicator extinguishes and the BEAM ON indicator illuminates. Verify that a helix current reading is obtained on the HELIX CURRENT meter. Verify that this helix current reading is consistent with the tube data sheet supplied with the unit.

CAUTION

Prior to performing step e. check the TWTA data sheet to determine the proper RF drive level. Do not exceed this level by more than 6 dB. Over-drive of the TWTA could cause damage to the equipment.

e. Apply RF drive and verify, by using an external power meter, that RF is being amplified. If no reading is obtained on the external power meter, increase the RF input power until the desired output is obtained. Compare the gain and output power to the TWTA data sheet to verify proper operation.

f. Set the OPERATE/OFF/RESET switch to OFF/RESET. Verify that the BEAM ON indicator extinguishes and the STANDBY indicator illuminates.

The Power Amplifier is now ready for operation.

4.5 NORMAL TURN-ON

Once the steps defined in Section 4.3 have been completed, normal turn-on can be accomplished very simply, unless there is reason to suspect that a significant change in operating conditions has occurred during the off time. The following steps assume that the normal turn-off procedure has been followed.

a. Place the Power Switch in the ON position and verify that the LOGO and TIME DELAY indicators are illuminated.

b. When the heater time delay is complete, verify that the TIME DELAY indicator extinguishes and that the STANDBY indicator illuminates. Set the OPERATE/OFF/RESET switch to OPERATE and verify normal helix current.

c. If automatic turn-on is desired, the OPERATE/OFF/RESET switch should have been set to OPERATE prior to turn-on. In this mode, when the heater time delay is complete, the unit will automatically return to full operation with high voltage ON and RF output.

4.6 TURN-OFF

If the Power Amplifier is to be turned off for a short time (e.g., less than 2 hours) it should be placed in STANDBY by setting the OPERATE/OFF/RESET switch to OFF/RESET. This permits the blower to run and minimizes thermal and electrical shock on the heater. If the off-time is to be extended, the unit should be turned off completely to save heater life and prime power.

a. Set the OPERATE/OFF/RESET switch to OFF/RESET to turn high voltage off.

b. Let the system run in the STANDBY mode for several minutes in order to cool the TWT and all other components.

c. Place the Power Switch in the OFF position to remove prime power from the unit.

d. If automatic return to full operation is desired on subsequent turn-on, the OPERATE/OFF/RESET switch may be left in the OPERATE position when the main power is turned off. This operation is permissible but is generally not recommended, because it products a thermal rise in the TWT at turn-off, and because turn-on will occur without an operator verifying that normal conditions exists.

NOTE

This TWTA is equipped with fast response fault detection circuits. If you "flip" the OPERATE/OFF/RESET switch from OPERATE to OFF/RESET and back on again you may induce faults. When you turn the BEAM OFF wait 1 second before returning to OPERATE again. If there is a fault indication after a very short prime power interruption, this is normal and the Fault Recycle and Indicator PWB A8 will automatically clear such faults.

SECTION 5

THEORY OF OPERATION

5.1 GENERAL

This section describes the Theory of Operation for the 100/200 watt general purpose TWTA series with a full set of options and special features incorporated in the unit. The options and special features include:

a. Choice of prime power
b. Local or remote operation
c. Fault recycling
d. High load VSWR protection, and
e. Metering of TWT running time

NOTE

Your TWTA probably does not include every option and special feature. Check Section 1 and Section 7 for specific configuration data on your unit.

Understanding the Theory of Operation is a necessity for the technician who will maintain the equipment, and an asset for the operator. A thorough understanding of the Theory of Operation of the equipment provides for a more efficient operation, and quicker and more effective repairs if problems develop. This section should be completely understood prior to any maintenance activity being conducted on the system.

NOTE

Unless noted otherwise, the reference designators used in a particular section relate to the unit being discussed. Since there are identical reference designators on various PWBs, reference

designators for assemblies other than the one being discussed carry the assembly designator. For example: 1A7C1 would refer to capacitor C1 on the A7 assembly.

5.2 POWER SUPPLY

5.2.1 Basic Design Concept

The Power Supply design is based on proven reliable circuits that have been used on numerous communication ground station amplifiers. A functional block diagram of the Power Supply is presented in Figure 5-1. Design efficiency and reliability are obtained by using a switch regulator approach for primary regulation. Optimum regulation and RF performance are obtained by the use of direct feedback (helix voltage sense) from the high voltage DC output to the switch regulator. Over-current/under-voltage protection circuits are incorporated in the heater and helix/cathode supplies to prevent damage to these supplies in the event of a failure in the TWT and to prevent damage to the TWT in the event of a power supply failure.

The Power Supply is mounted on a 1/4" aluminum baseplate and occupies the top 8" of the 12-1/4" chassis. The lower 4" contain the TWT and all RF circuitry. The physical arrangement is designed to allow rapid easy access for maintenance and service of the unit. The bulk of the circuitry is on printed wiring boards (PWB) that are interconnected by flat cable assemblies or screw terminal connections to chassis mounted components. The following discussion incorporates simplified circuit diagrams for illustrative purposes. Up-to-date detailed schematics for the TWTA, the Power Supply and the various printed wiring boards are included in Section 7 of the Power Supply portion of this technical manual. As appropriate, these schematics are referenced as the A3 schematic, the A5 schematic, etc. The specific drawing number of these schematics is listed at the beginning of Section 7 and the drawings are arranged in Section 7 in accordance with the indenture (UD) system.

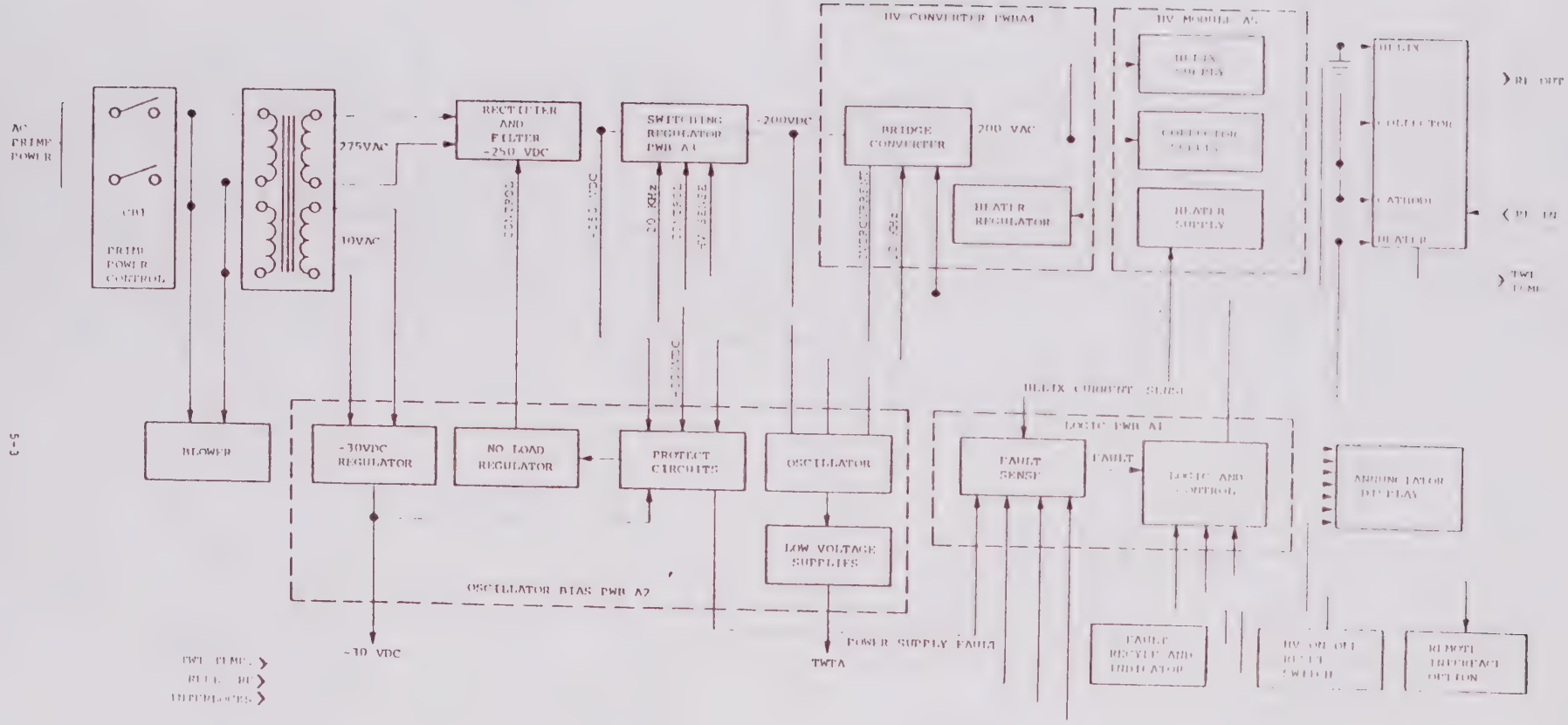


FIGURE 5-1 FUNCTIONAL BLOCK DIAGRAM - POWER SUPPLY SUBSYSTEM

5.2.2 Power Conditioning

The power conditioning circuits interface with the AC prime power[1] source; control and protect application of prime power to the TWTA; and transform the AC input into a DC voltage that is fed to the switch regulator. A schematic of the power conditioning circuits is presented in the UD1 schematic.

The prime power connection is made at TB2 which is located on the rear panel of the TWTA and is part of the RFI Filter FL1. The output of FL1 feeds a two pole single throw circuit breaker (CB1) which is used to control application of prime power to the rest of the TWTA. CB1 applies prime power to transformer T1 through a surge limiting circuit consisting of resistor R1 and a set of relay contacts of relay K1. Relay K1 is controlled by Oscillator-Bias PWB A2. Upon application of power, R1 limits the turn-on surge current to less than 300% of normal operating current. K1 energizes and shorts out R1 in less than 1 second.

Blower B1, in the 115 Vac configuration, is connected in parallel with the primary windings. B1 is connected across one of the primary windings when the TWT is configured for 230 VAC operation (see Figure 3-1).

The output of secondary 1 of transformer T1 is 38 VAC This output is connected to the Oscillator/Bias PWB A2 where it is rectified and processed to generate a -38 VDC unregulated supply and a -30 VAC unregulated supply. (See Section 5.2.3.1.)

The output of secondary 2 of transformer T1 is 275 VAC. This output is fed to SCR bridge rectifier CR1. In normal operation, CR1 acts like a conventional bridge rectifier. The major difference between CR1 and conventional bridge rectifiers is that two SCRs are incorporated in the device. A positive signal on the SCR gates (G1, G2) will cause the SCRs to conduct.

(1) See Table 1-2 for prime power options

Once an SCR fires, it will not turn off until the applied voltage is reversed or removed. Since the applied voltage (275 VAC) reverses every half cycle, removal of the gate signal allows the SCR to turn off within one cycle. This allows fast acting control of the primary supply voltage of the TWTA when a fault occurs. (See Section 5.2.7.5 for a discussion of fault detection circuits.) CR1 is also used to limit the maximum DC voltage to the switch regulator during light or no-load conditions. See Section 5.3.2.5 for a full discussion of this circuit.

The output of CR1 is filtered with inductor L1 and capacitor C1 and results in an unregulated -250 VDC nominal output. The -250 VDC output is fed to Switch Regulator A3 which in turn feeds the high voltage circuits. (See Section 5.2.4)

5.2.3 Oscillator/Bias PWB Assembly A2

As shown in Figure 5-1, the Oscillator/Bias PWB contains a variety of functions. A block diagram of the Oscillator/Bias PWB is presented in Figure 5-2. Circuit details are presented in the A2 schematic. The functions included on the board are:

a) -38 VDC Supply, unregulated
b) -30 VDC Supply, unregulated
c) 29 VAC Supply, 10 kHz square wave
d) +5 VDC Supply
e) -5 VDC Supply
f) ±15 VDC Supply
g) +12 VDC Supply
h) Sync Signal for Switch Regulator & Converter Drive
i) -250 VDC Bleeder Circuit
j) -250 VAC No-Load Regulator
k) -200 VDC Overvoltage Protection
l) Surge limit and -250 VDC Undervoltage Protection
m) -38 VDC Undervoltage Protection
n) -200 VDC Undervoltage Protection

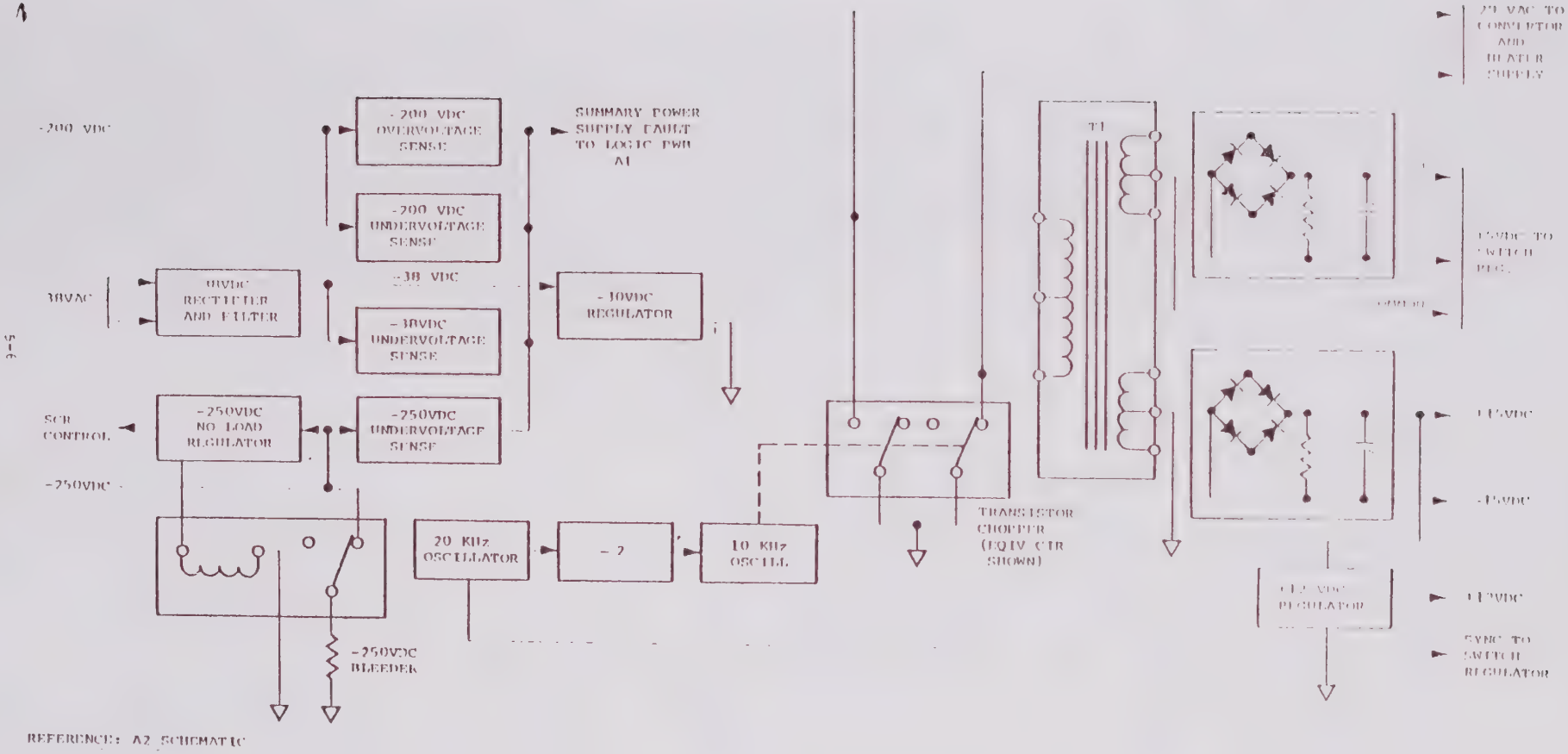


FIGURE 5-2 FUNCTIONAL BLOCK DIAGRAM-OSCILLATOR BIAS PWB A2

5.2.3.1 Service Voltage Supplies. A block diagram of the circuits that generate the various service voltages (-30 VDC regulated, -12 VDC regulated, ±5 VDC, +15 VDC, +12 VDC and 29 VAC) is presented in Figure 5-2. As discussed in Section 5.2.2, the power conditioning circuit transformer is used to step the 115/230 VDC 50-60 Hz prime power down to 38 VAC. This is the source voltage for the service voltage supplies. The 38 VAC is converted to -38 VDC by full wave rectifier CR1 and filtered by C1. The -12 VDC supply voltage required for operation of the 20 kHz square wave sync generator is taken from zener diode CR2 and capacitor C2 which operate directly from -38 VDC. The -38 VDC is monitored by an undervoltage protection circuit (see Section 5.2.3.5) and fed to a precision series regulator consisting of Q1, Q2, Q3, Q4, Q5 and A1 and their associated parts. The output of this regulator is a -30 VDC regulated voltage which is converted to a 29 VAC 10 kHz square wave.The 29 VAC voltage is used to power the TWT filament supply and to drive the other low voltage supplies required for operation of the TWT. The low voltage supplies are conventional full wave rectifier circuits driven by the secondary of transformer T1. The +12 VDC supply for the control, logic and protection circuits is obtained by using a standard 3 terminal regulator with internal short protection.

The 38 VDC is series regulated by Q2, A1 and their associated parts. Q2 is the pass transistor with Q3 connected as a complimentary darlington. Q1, R1, R2, R5, CR33, CR34 form a constant current driver for the darlington pass transistors. The drive current is 5 mA as set by the value of R5. R10, R11, Q4, C4 are the load current limit circuit. R10 determines the limit point which is 2.5 to 3 Amps. R1, R2, R9 and CR6 are a fold-back circuit which goes into effect when the output voltage of the regulator drops below the voltage at junction of R1 and R2 ($\approx$ 25 volts). When a short circuit occurs, the current limit point drops to about 1 amp or less. A1, with its associated sense resistors R18 and R19, form a shunt regulator which diverts drive away from Q3 to maintain regulation at -30 VDC. A1 generates a precision +7.15 VDC reference voltage at pin 4 which is referenced to the -30 VDC line.

This is compared with a sample of the -30 VDC at pin 3 of A1. The difference between pins 2 and 3 of A1 is amplified by A1 and applied to a transistor that is internal to A1. This internal transistor controls the drive current to Q2 and Q3. R12 and C7 are a compensating network used to obtain stable operation. C5 is the -30 VDC line output filter.

Transistor Q5 is used as a zener diode in which the base to emitter junction acts as a zener diode of approximately 8 VDC with the collector to base junction forward biased.

The operation of the 10 kHz chopper circuit is described in Section 5.2.3.2.

5.2.3.2 Sync and Converter Drive Circuits. The Oscillator/Bias PWB includes circuits that generate 20 kHz voltage; convert the 20 kHz voltage to a 10 kHz voltage; and convert the -30 VDC regulated voltage to a 29 volt 10 kHz voltage. A functional diagram of the related circuits is shown in Figure 5-3. A timing and wave form chart is also included in Figure 5-3.

The square wave generator products a 20 kHz square wave that is used to drive the switching regulator. This voltage is also converted from 20 kHz to 10 kHz and used to convert the -30 VDC supply voltage to a 10 kHz, 29 VDC voltage that is the supply voltage for the low voltage supplies discussed in Section 5.2.3.1 and the filament supply (Section 5.2.5.1) The 20 kHz voltage is converted to two symmetrical 10 kHz square waves by one-half of a dual "D" type flip-flop (U2B) at pins 1 and 2. The other half (U2A) is connected as a one-shot multivibrator using R32, C12 and CR14. A 5 μsec pulse is developed at pin 12 of U2A at a 20 kHz rate. The 10 kHz square wave is "NANDED" with this signal by U1C and U1D. The outputs at U1-10 and U1-11 are out-of-phase quasi-square waves with 5 μsec of dead time that minimizes losses due to charge storage time in the HV bridge converter transistors.

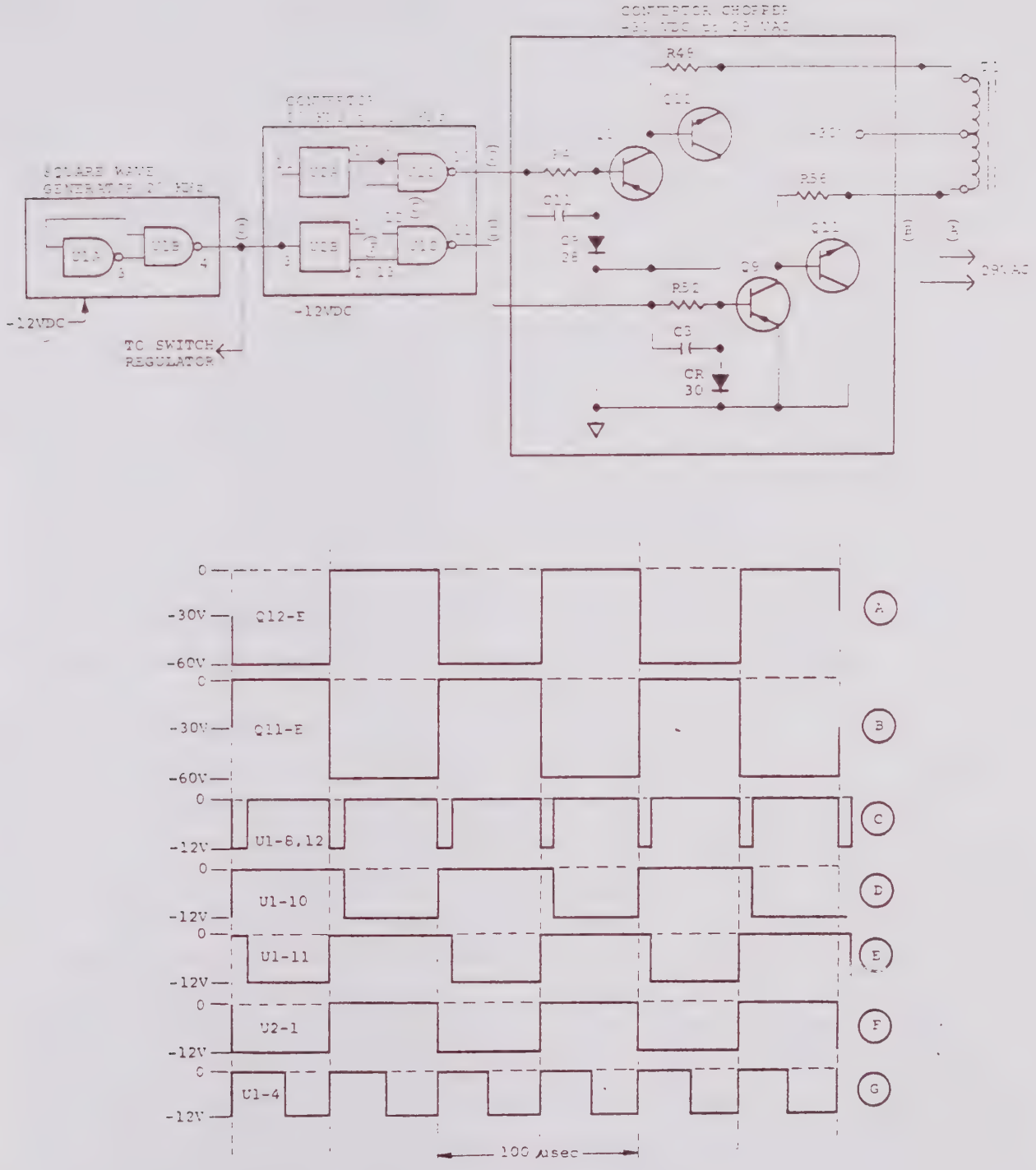


FIGURE 5-3 FUNCTIONAL BLOCK DIAGRAM AND TIMING CHART
20 KHz AND 10 KHz CIRCUITS

The out-of-phase 10 kHz square wave outputs of U1C and U1D (U1-10 and U1-11) are fed to push-pull transistors Q11 and Q12 through drivers Q9 and Q10. The center tap of transformer T1 (T1-2) is connected to -30 VDC. The output of the converter chopper is a 29 VAC (10 kHz) voltage that is applied to transformer T1 to develop the low voltage supplies and through an isolation transformer to a full wave bridge rectifier in the HV module to develop the filament supply voltage.

5.2.3.3 -250 VDC Regulation and Protection. The -250 VDC supply voltage generated by the power conditioning circuits is regulated to limit its magnitude to less than 300 volts and monitored to shut down if the magnitude falls below -160 volts. Circuit elements are also incorporated to discharge the -250 VDC filter capacitor (C1) whenever the power supply is turned off and to inhibit surge currents in the primary of transformer T1. (See Figure 5-4). The over-voltage regulation and under-voltage protection circuits are very similar in that a comparator is used to control a transistor which controls an element that performs the desired function. (See Figure 5-4).

5.2.3.3.1 No-Load Regulator: The No-Load Regulator limits the magnitude of the -250 VDC supply voltage during turn-on. The SCRs included as part of CR1 on the chassis are the control devices. With no drive signals to the SCR gates, the -250 VDC is turned off. Q6 controls the SCR gates. During normal (-250 VDC) operation, transistor Q6 conducts which impresses a positive voltage on the SCR gates through resistors R3, R4, R7, R8, and R22. This allows the SCRs to turn on and act as normal diodes. The voltage at A2 pin 2 is the reference voltage of approximately +6 VDC. Whenever the sense voltage at A2 pin 3 goes negative with respect to pin 2, A2 pin 8 goes positive and turns off Q6 which disables the 250 VDC. R26, R30, R31 is the sense circuit. R26 allows positive feedback to provide some hysteresis for clean on-off switching. During no-load conditions, when the (-) 250 VDC actual magnitude exceeds (-) 300 VDC, Q6 disables

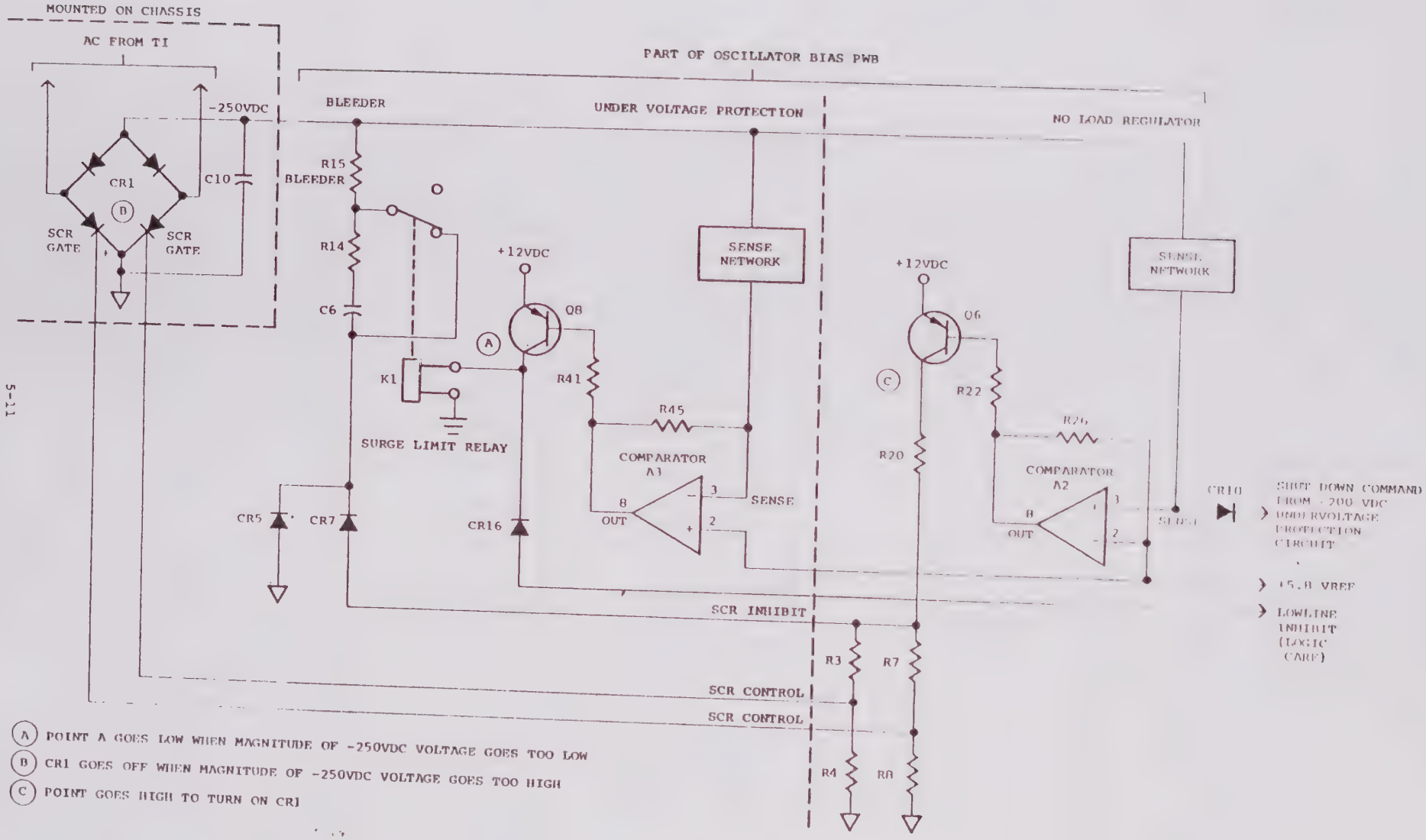


FIGURE 5-4 FUNCTIONAL BLOCK DIAGRAM-
-250 VDC REGULATION AND PROTECTION

the SCRs. The -250 VDC then decays until the magnitude reaches approximately -295 where Q6 turns on. The voltage magnitude then rises to -300 VDC and is turned off again. The action repeats so that the voltage appears as a sawtooth wave going between -295 VDC and -300 VDC .

5.2.3.3.2 Undervoltage Protection and Surge Limit Relay Control: This circuit provides two functions:

a. Shut down of high voltage if the magnitude of the -250 VDC input is too low.
b. Limits inrush surge current during initial turn-on.

Operational Amplifier A3 is used as a comparator. A reference voltage is applied to pin 3 of A3 by Zener CR8 and resistor R47. Pin 2 of A3 is held at +12 volts when there is no -250 VDC supply voltage. Until the -250 VDC value reaches the proper value, pin 2 is positive with respect to pin 3 and the output of A3 on pin 8 is high which hold Q8 off. When pin 2 is negative with respect to pin 3 the output on pin 8 goes low turning Q8 on.

Q8 provides the drive current for surge Relay K1 located on the chassis. A normally open set of contacts of Relay K1 are connected across surge resistors R1 which is in series with the primary winding of transformer T1. When Q8 turns on and actuates relay K1, these contacts short out R1.

When the magnitude of the -250 VDC supply drops to about -160 VDC the output (pin 3) of A3 will go high, Q8 will turn off and relay K1 will be de-energized.

Anytime Q8 is off, the low line inhibit is driven low via A3CR16. This line control High Voltage control latch U10D on logic PWB A1. This means that high voltage is turned off and the surge resistor is enabled any time the magnetude of the DC input into the switch regulator falls below 160 VDC . (see Figure 5-4).

5.2.3.3.3 Bleeder Circuits: A bleeder circuit is provided to discharge the -250 V capacitor C1 located on the chassis when prime power is removed. The bleeder circuit path consists of R15 through K1 contacts and CR5. When the -30 volts supply is activated, relay K1 is energized through CR9. The shunting action of the contacts of relay K1 is thus removed and R14 and C6 are connected in series with R15. During the discharge period, CR7 pulls the gates of the power conditioning circuit bridge rectifier SCRs negative disabling the no-load regulator, shutting off the -250 VAC supply. When primary power is interrupted, C8 keeps K1 energized for a few seconds to prevent the bleeder from being connected during short term power outages.

5.2.3.4 -38 VDC Under-Voltage Protection. A comparator (A4) is used to monitor the -38 VDC voltage and generate a HV turnoff signal when the magnitude of the voltage drops below approximately -30 VDC . CR23 establishes a reference input of 5.8 VDC to A4-2. R57 and R59 sense the -38 VDC and connect to A4-3. This point is normally about +4 VDC . When the magnitude of this input reaches about +5.8 VDC , A4 will fire and A4-8 will go low. This pulls the low line inhibit output at J2-13 low through CR17 which pulls down the HV control logic line for a logic HV turn-off command.

5.2.3.5 -200 VDC Under-Voltage Protection. This circuit also uses a comparator (A5) to monitor the voltage level and performs two functions:

a. A5 provides a HV turnoff signal to the logic PCB if the -200 VDC drops to a magnitude less than -110 VDC .
b. It gives a visual indication via an LED which is located on the PCB when a -200 VDC under-voltage occurs.

The -200 VDC is sensed via R70 and R71 and connected to A5-3. This is compared with a reference voltage of +6.2 VDC set by zener diode CR38 and connected to A5-2. When something causes the magnitude of the -200 VDC supply to drop below -110 VDC (such as a short circuit), the input to A5-3 rises above 6.3 V. This causes the internal output transistor in A5 to turn on and provide an output at A5-6 which turns on SCR CR27. Once turned on CR27 remains on regardless of gate voltage and provides a path for LED CR26 to illuminate. The summary fault line (PS FAULT) at J2-4 is pulled low through CR25. A path through CR24 and CR10 pulls the no-load regulator low at A2-3 which causes CR1 located on the chassis to turn off.

A voltage reference of +5.8 VDC is established by R68 and CR38. The voltage sense circuit consists of R69, R70 and R71. In the standby mode, the HV control switch through CR29 holds A5-3 low and inhibits the -200 VDC undervoltage circuit from operating. When the switch is turned ON, the inhibit signal remains for C19 and R71 time constant. This allows the -200 volts to reach the proper voltage before the circuit becomes enabled.

SCR CR27, which is a latching device, can be reset by a logic low on the automatic reset line through CR33 by turning the high voltage switch off and on or by the fault recycle PCB when this option is present.

5.2.4 Switch Regulator PCB A3

5.2.4.1 General. This function of the switch regulator is to maintain a well regulated approximately -200 VDC buss that drives the high voltage circuits. The -200 VDC referred to throughout the text may actually be any voltage between -140 and -220 VDC and is determined by the TWT helix voltage required and high voltage module connections. This unit also incorporates features to control the HV converter and to respond to external shutdown commands from other circuits. A functional block diagram of the Switch Regulator is presented in Figure 5-5. This figure indicates the section of the manual that

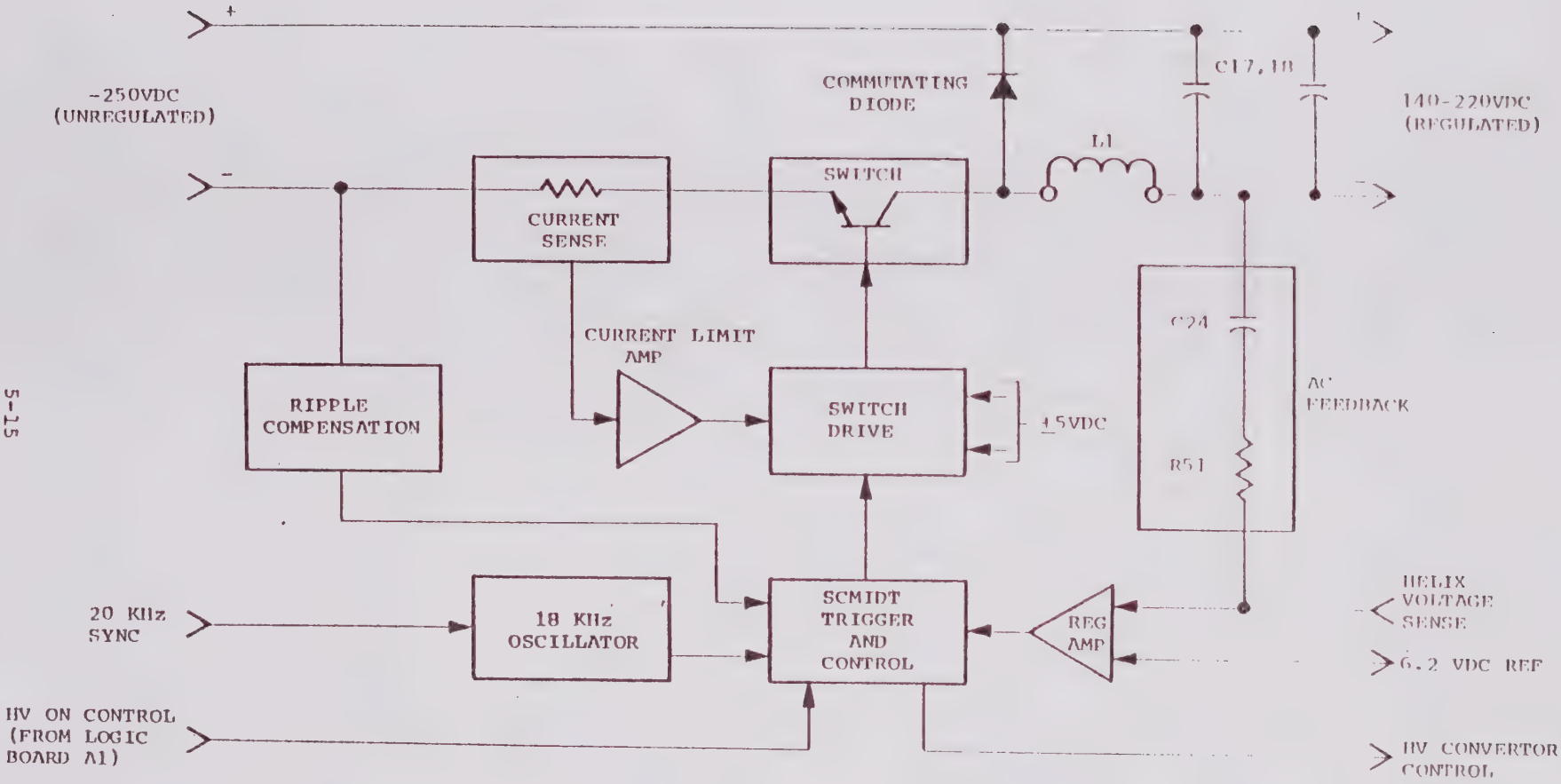


FIGURE 5-5 FUNCTIONAL BLOCK DIAGRAM SWITCH REGULATOR

discusses each function. The power handling circuits are shown in the top half of Figure 5-5, and the control circuits in the lower half of the figure. Circuit details are given in the A3 schematic in Section 7.

5.2.4.2 Current Limiting Circuits. The current limiting circuits limit output current at approximately 20 amps. Current drawn by the power switching circuits develops a voltage across R6. This voltage is approximately 150 mV at the current limiting point. This voltage is amplified by A1 to about 3 V which charges up C7 through CR5 and R15. The feedback resistors R5, R7 and R10 set the gain of A1 and determine the discharge time constant of C7. R5 adjusts the limit point from 0 to 20 amps. C7 voltage is then applied to a threshold detector circuit consisting of A2 and its associated parts. R16 and R17 set the threshold level. R21, a feedback resistor, determines the hysteresis to provide clean on-off characteristics. When the threshold is exceeded, A2-8 pulls to the -250 V buss and diverts drive away from the input to the power switch circuits thus turning off the power switches. The circuit stays off until C7 discharges through R10, R7, R5, 54 and R6. Then the circuit cycles on again. This will continue until the current falls below 20 amps. The frequency of operation in the current limit mode is determined by the time constant of C7 and the switch regulator filter constants and is about 11 kHz. CR1 and C1 provide a 6.2 V power supply to operate the current limit circuit.

5.2.4.3 Power Switching Circuits and Output Filter. These circuits consist of Q4 through Q10, L1 and associated components. They operate as a duty cycle modulated switch and integrator in series with the -250 VDC buss. When drive is diverted from Q8 by the current limiter on the power switch control circuits, operation of the power switch circuits is inhibited and there is no -200 VDC output.

Q6 and Q7 are driven in parallel to switch the -250 VDC buss. Q6 and Q7 in combination with Balum transformer T1 and resistors R39, R40, R41 and R42 form a balanced switching network. T1 provides dynamic

current balance between Q7 and Q7 during the portion of time in which switching occurs. The resistor network provides for DC current balance after switching is completed. The result is that throughout the operation of this circuit, Q6 and Q7 share current equally during on-time.

The output of Q6 and Q7 is a pulse train that is filtered and integrated by the output filter consisting of choke L1, C17, C18. Capacitors C17 and C18 discharge through resistors R47 and R50 respectively during the time when Q6 and Q7 are off.

The ratio of on-time to off-time, in combination with R49, R50 and the load resistance, establishes the DC voltage output of the filter. The -200 VDC output is regulated by the power switch control circuits by varying the on-time/off-time (duty cycle) ratio. This method of regulation is much more effective than traditional series regulation circuits that dissipate power to achieve regulation.

For power efficiency and reliability reasons, it is desireable to cut off Q6 and Q7 very quickly. A snubber circuit is incorporated in the design to momentarily hold the collector of Q6 and Q7 at -250 VDC at the end of an on-time period to allow for stored charge removal in the base to emitter junction. During an on-time period, capacitor C16 charges to -250 VDC through R45. This reflects in a waveform similar to that shown in Figure 5-6. The snubber prevents the energy stored in the filter choke and capacitors from discharging through Q6 and Q7. After Q6 and Q7 are off, the commutating diode CR20 fires and diverts the stored energy. C16 stores enough charge to provide current flow in L1 through CR19 which prevents an inductive pulse at the collectors of Q6 and Q7 until they are shut off. C15 and R43 attenuate ringing across CR19 caused by R45 inductance.

Q9, Q10, R34, R35, CR17 and CR18 form a current source circuit that provides the base drive ($\approx$ 2A) for Q6 and Q7. Q4, Q6 and CR10 provide a reverse current path for fast turn-off ($\approx$ .5 μsec.) of Q6 and Q7. Q5 is biased on by R28 through CR11 and R56. Q10 and Q9

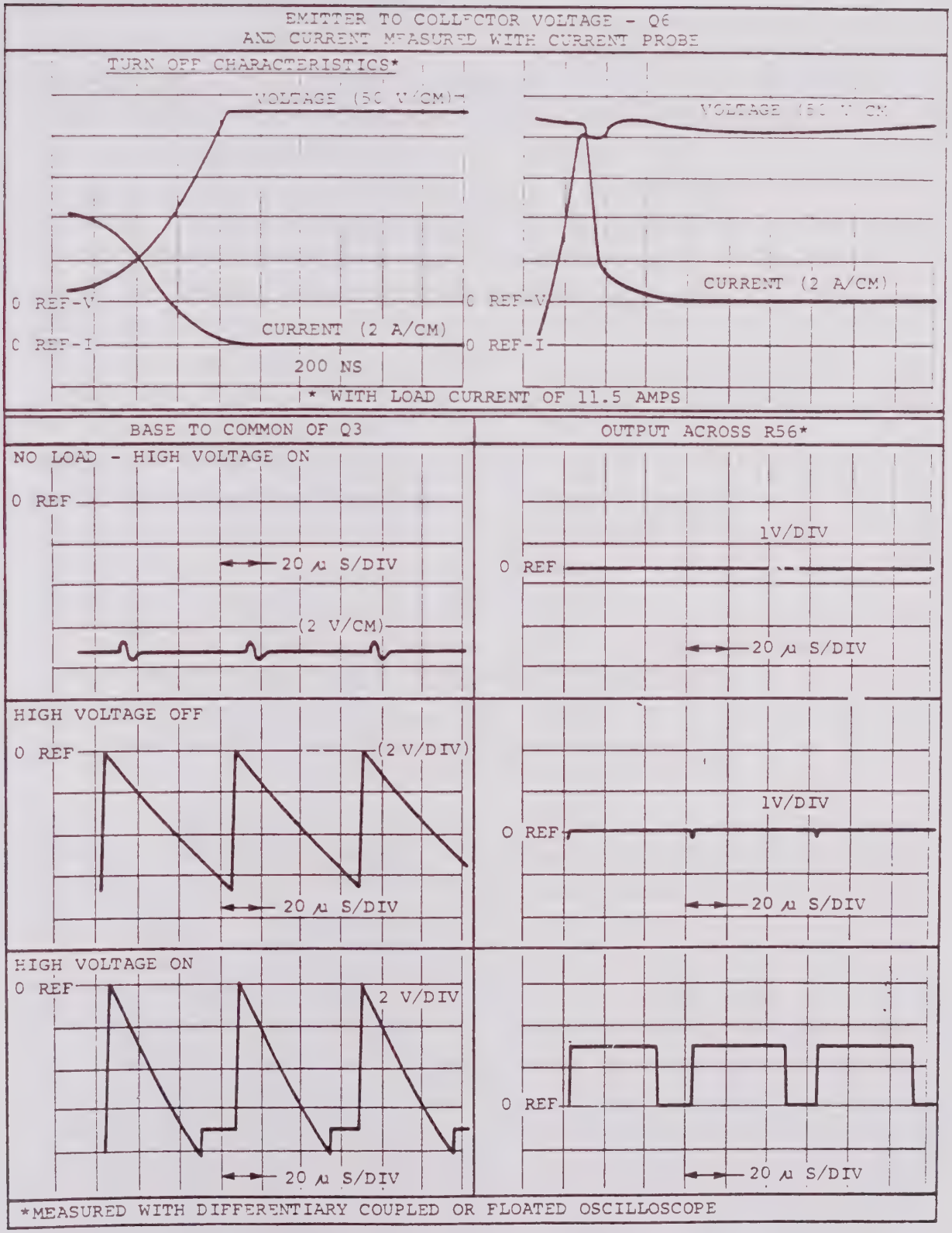


FIGURE 5-6 SWITCH REGULATOR WAVE FORMS

receive their drive through R26 and R30 from Q8. Q5 is turned off simultaneously with Q8 turning on by having its drive diverted away through CR12. C11 serves to make the circuit less noise sensitive. Q8 is driven by the power switching circuits through a 12 V zener diode, CR13.

5.2.4.4 Power Switch Control. The Power Switch Control is a Schmitt trigger that generates square wave pulses. The power switches (Q6 and Q7) are driven by the Power Switch Control through CR15, CR14 and CR13. CR13 and CR14 combine to shift the -250V supply down by 132V at Q11. When the input to Q3-B is low, Q11 is on and the power switches have drive applied. Each time the base of Q3 is raised to a voltage of about 7 volts, Q3 turns on which shuts Q11 off and switches the power switch Q6, Q7 off. Q3, Q11 and their associated parts form a Schmitt trigger. CR8, CR9, R36 and R37 with Q11 form a constant current ($\approx$ 2.5 mA)output stage. R37 also sets the hysteresis of the circuit. CR16 and R38 add 6.2 Vdc offset above circuit ground to the Schmitt trigger input Q3-B. U2, an optical coupler, provides a turn-on command to the circuit through Q2, CR7 and R32. No drive can reach the power switches (Q6 and Q7) when U2 and Q2 are off because in this state they open the drive circuit path for and inhibit operation of Q11.

5.2.4.5 Synchronized Oscillator. U1A and B form a free-running oscillator which operates at approximately 18 kHz. The oscillator is then synchronized and drives the power switch control at a pulse rate of 20 kHz. The drive pulses are about 1 µsec in width.

This oscillator is synchronized by a 20 kHz pulse from the osc/bias circuit. The pulse at pin 12 is applied to pin 6 (the gate of a MOS FET transistor) the drain of which (pin 13) is used to discharge C8 to zero volts once every 50 µsec. C8 is charged by a current source formed by Q1, R22, CR25 and R19. C8 voltage is applied to the power

switch control Schmitt trigger input (Q3-B). When C8 voltage is less than the trigger threshold ($\approx$ 7 V) Q3 is off, Q11 on, which turns on power transistors Q6 and Q7 through the drive circuits. When C8 voltage reaches threshold, Q3 turns on, Q11 turns off which removes drive from the power switch. At the end of about 50 μsec., U1-13 discharges C8 to 0 and the cycle starts over again. This charge-discharge cycle in C8 and the associated state of Q11 of the power switch control are shown in Figure 5-6.

5.2.4.6 Ripple Compensation Circuits. The ripple compensation circuits help to reduce the output ripple on the -200 V output by a feed forward technique. The combination of Q1, R22 and CR25 acts as a constant current generator to charge C8. The adjustable network of R28, R18 and C20 provide an adjustable charging current for C8 that is proportional to the magnitude of the ripple components on the -250 VDC buss. The charging rate of C8 is inversely proportional to the -200 VDC and ripple so that adjustment of R29 allows the output ripple voltage to be minimized.

5.2.4.7 High Voltage Regulator Circuits. Feedback from the high voltage sensing circuits to A3 provides the signals necessary for good load regulation and temperature stability with very fast reaction times. A3 is an operational amplifier. A reference voltage of 6.2 VDC is established by R48, CR21 and R58 on A3-2. This is compared to the helix voltage sample from J2-2 across R55 and R53. A3 amplifies this and diverts some of the charge current to C8 proportionally to the error signal between A3-2 and A3-3. This changes the duty cycle on the power switches Q6, Q7 through Q3 and provides a linear regulator loop. The use of these circuits results in a tightly regulated switch regulator output with instantaneous response to input pertubations. C19 and R44, R49 are used to set the loop stability. C24 and R51 are used for test and maintenance purposes and along with C23 and R48 provide an AC feedback path which increases loop gain at higher frequencies.

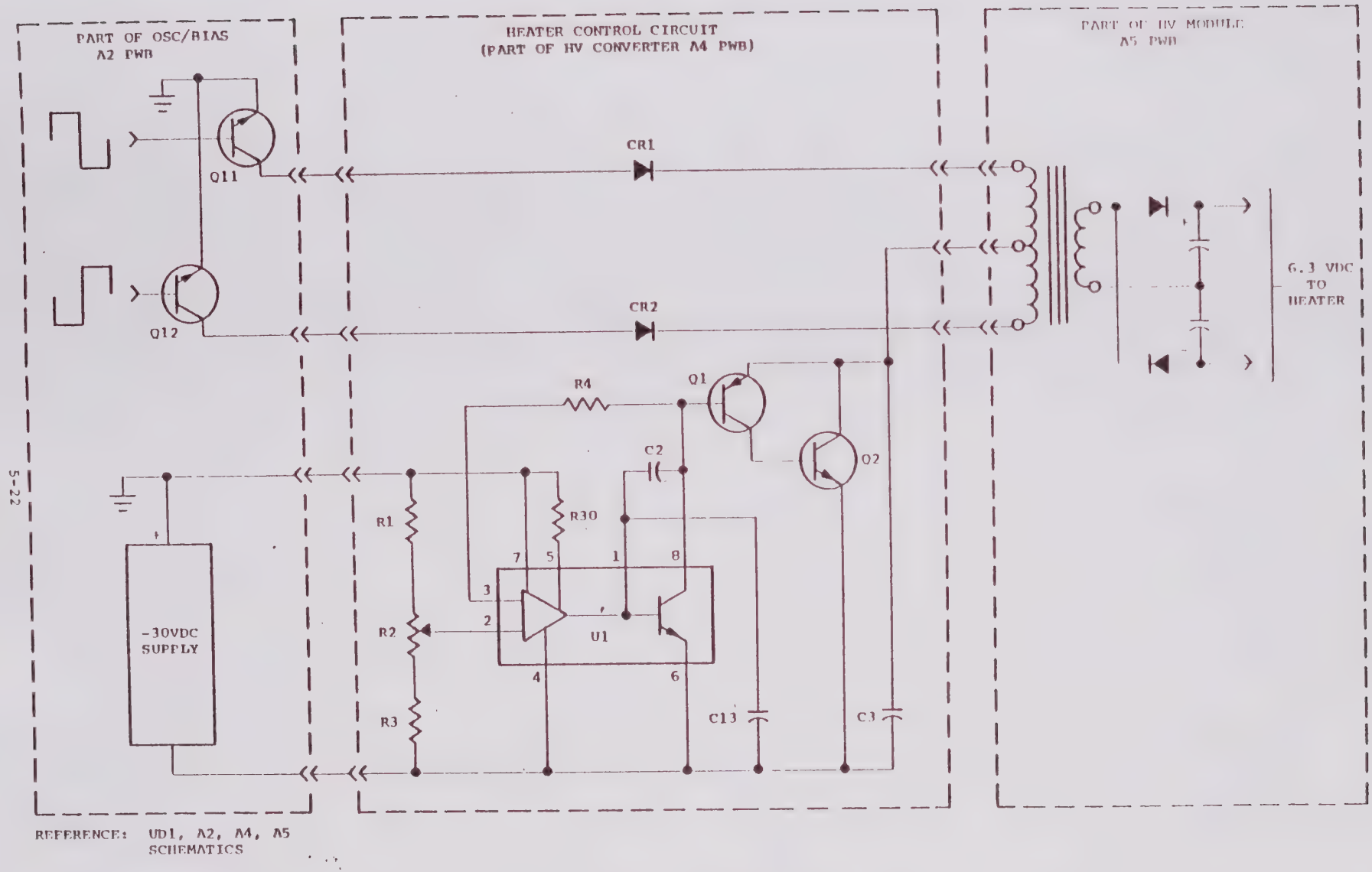
5.2.5 High Voltage Converter and Heater Supply PWB

A4 circuit details are presented in the A4 Schematic in Section 7. The functions of this PWB are:

a. Control of TWT heater supply voltage level (Section 5.2.5.1).
b. Conversion of regulated -200 VDC input from switch regulator to 200 VAC (square wave) for high voltage transformer in high voltage module (Section 5.2.5.2).
c. Control of the 200 volt converter operation (Section 5.2.5.3).
d. Monitor current in primary of high voltage transformer and provide overcurrent protection (Section 5.2.5.4).

5.2.5.1 Heater Supply Control. The operation of this circuitry can be best understood by looking at the entire TWT heater circuit. As shown in Figure 5-7 the heater supply is distributed on three functional elements. These are:

a. Osc/Bias Assembly which generates the -30 VDC and 29 VAC 10 kHz square wave drive. This is discussed in Section 5.2.3.2.
b. HV converter (heater control circuit) which provides the active control and adjustment circuits to be discussed here. These circuits control the magnitude of the 29 VAC applied to the HV module.
c. HV module which contains the TWT heater transformer, rectifier and filter circuits. This is further discussed in Section 5.2.6.



REFERENCE: UD1, A2, A4, A5 SCHEMATICS

FIGURE 5-7 HEATER SUPPLY

R2 sets a reference input to U1-2 that is adjustable between 0.5V and 5.0 VDC. R4 sets the loop gain of U1 to unity so that the output at U1-8 is the same as U1-2. This output is applied to Q1 and Q2 which function as an emitter follower. The DC voltage at Q2-C is than 0.7 VDC higher than the set point of R2 and sets the maximum voltage across T1 primary. The AC current path for T1 is through Q2 and CR1 or CR2 on alternate cycles. Capacitors C2, C3 and C13 are for compensation of the heater control circuit.

5.2.5.2 200 Volt Converter. The output of the converter drives the high voltage transformer of the high voltage module. The input to the converter is the regulated DC output of the switch regulator. This input of 140-220 VDC is converted to a 140-220 VAC 10 kHz square wave. Q7, Q8, Q9 and Q10 form a bridge converter that is driven by a 29 VAC 10 kHz signal on the primary of Transformer T1. In operation, Q7 and Q10 are driven on when Q8 and Q9 are driven off. Alternately Q8 and Q9 are driven on when Q7 and Q10 are driven off.

CR6, CR8, CR11 and CR12 prevent reverse currents from flowing in Q7-10 during the dead time interval (whenever the transistors are off). T1 is the base drive transformer which provides a 5 V square wave drive for Q7-10. L1, 2, 3, 4 are saturable reactors that delay the base drive about 7 μsec. CR5, CR7, CR10 and CR16 bypass the reactors to prevent any turn-off drive delay. R24, R25, R21 and R20 limit the turn-on drive currents to a level of about 1 amp. C4 thru C7 and R26 thru R29 provide terminations for L1 thru L4 during the delay period. The delayed drive allows the ON pair of transistors to turn completely off before the OFF pair is driven on.

5.2.5.3 Converter Control Q3-6 and their associated parts form a control circuit that controls the 29 VAC drive from T1 by controlling the AC current path for T1 primary at the center tap, T1-2. Q4 and Q5 form the normal HV on/off switch that is activated by the switch regulator PWB. When -30 VDC is applied to J2-10, Q5 turns on allowing Q4 to turn on and complete the AC current path for T1 primary. T1, 1-2-3 receives 29 VAC from the oscillator bias circuit. Q3 and

Q6 couple in a turn-off signal from the HV converter overload shutdown circuit. When the overcurrent circuits (5.2.5.4) are activated, current is drawn through R14 which turns on Q6. This turns on Q3 which turns off Q4 and opens the transformer current path. This in turn cuts off drive to the converter.

5.2.5.4 Overcurrent Protection. The overcurrent protection circuits monitor the primary current of the high voltage transformer of the HV module. The circuits consist of T2, CR13, 14, 15, CR17 through CR23. A reference voltage controlled by R18 is placed on the gate of PUT CR15. Current transformer T2 provides an output voltage that is rectified, conditioned and applied to CR15. This voltage is proportional to the converter current. When this voltage exceeds the value on the gate of CR15, PUT CR15 turns on which turns on PUT CR14. This generates a fault command and turns on LED indicator CR13. CR18 connects the fault signal to the logic board. CR22 is used to connect the auto reset line so that CR14, which is a latching device, can be reset. As noted in 5.2.5.3, current through R14 will cause shutdown of the 200 volt converter. CR20 permits reset of PUT CR15.

5.2.6 High Voltage Module A5

Circuit details are given in the A5 and A5A1 Schematic in Section 7.

5.2.6.1 General. The HV module provides the following:

a. TWT DC Heater Supply.
b. TWT Collector power supply.
c. TWT Helix power supply.
d. Helix current metering and fault protection.

A functional block diagram of the HV module coupled to a TWT is presented in Figure 5-8. The 10 kHz inputs from the HV converter PWB are regulated busses. The helix and collector supplies share the same step-up high voltage transformer. A separate step-down transformer

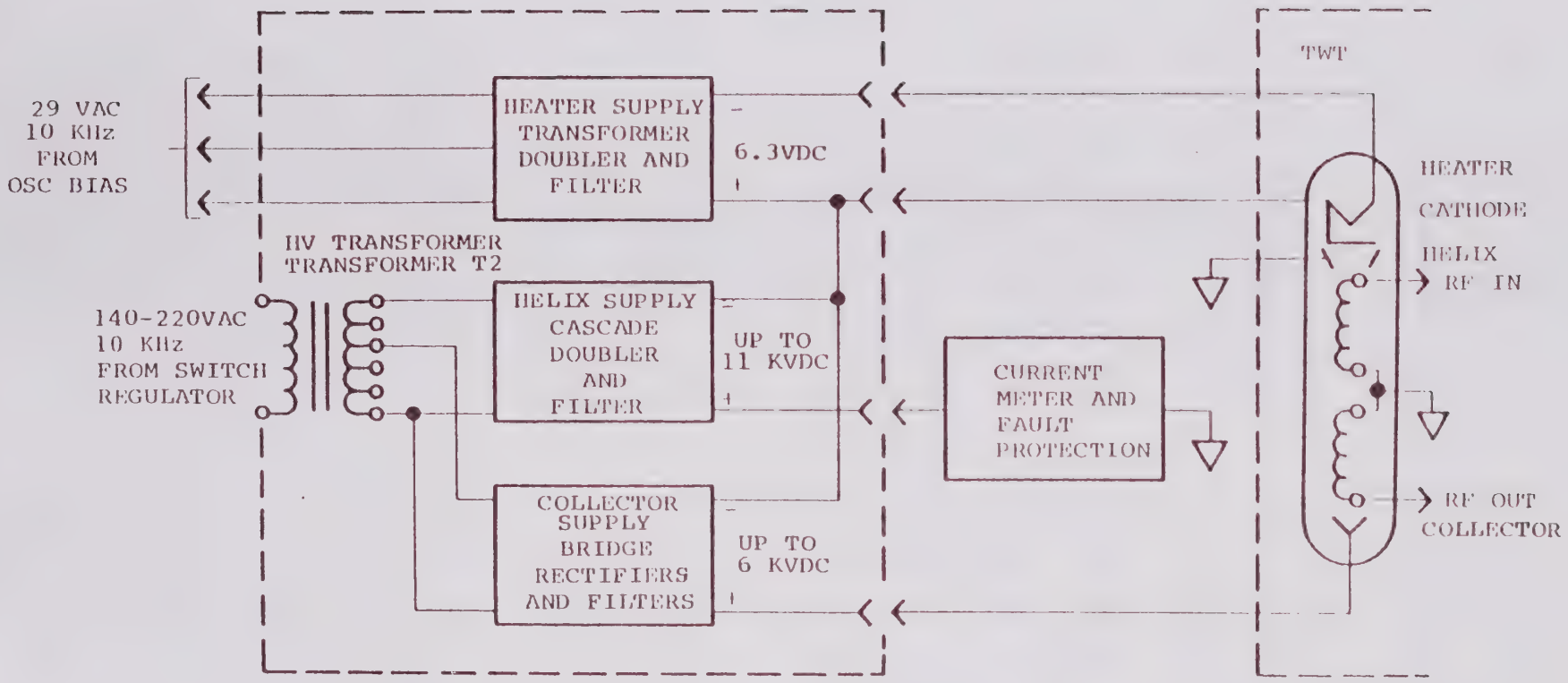


FIGURE 5-8 H.V. MODULE AND TWT

is incorporated into the heater supply. The HV module allows the collector voltage to be depressed below the helix voltage which extend the life and provides significant energy savings in the operation of the TWT.

5.2.6.2 Heater Supply. The circuit for the heater supply is shown in Figure 5-7. A 29 VAC square wave input on the primary of T1 is rectified and doubled by CR1, CR2 and filtered by C1, C2. Zener CR3 provides protection in the event of heater arcing.

5.2.6.3 High Voltage Transformer T2. This transformer is used for both the collector and the heater supplies. A 200 Vac regulated 10 kHz square wave is supplied to the primary from the HV converter PWB. The secondary is formed of 6 sectors connected in series. Different taps can be used for the collector and the helix circuits to depress the collector properly for a particular TWT tube type. Up to 50% depression of the collector is obtainable by using the full winding for the helix. This can be reduced to zero depression by selection of the proper tap.

5.2.6.4 Collector Supply. The collector supply circuits are shown in Figure 5-9. The secondary of T2 is connected to a bridge rectifier consisting of CR4, CR5, CR6 and CR7. A spark gap (Z1) is placed across L1 to provide arc protection. R1 and R11 are current limiting resistors.

5.2.6.5 Helix Supply. The helix and collector supplies share a number of components. A simplified schematic is shown in Figure 5-9. The circuit for the helix supply is a modified form of a cascade doubler. During the negative portion of the AC input cycle when the top of the transformer is negative (Figure 5-9a) diode CR8 is forward biased and C3 charges to peak voltage V_a. During the next half cycle (Figure 5-9b) CR8 is reverse biased and acts like an open circuit. The voltage V_c on the output of the transformer and the charge (V_h) of C3 are additive so that C1 and Cr are charged to $V_c + V_h$ through diode CR6 and CR9. Note that the helix to cathode voltage is $V_c + V_h$ and that the charge on capacitor C4 is V_h. Resistor R7 is a bleeder

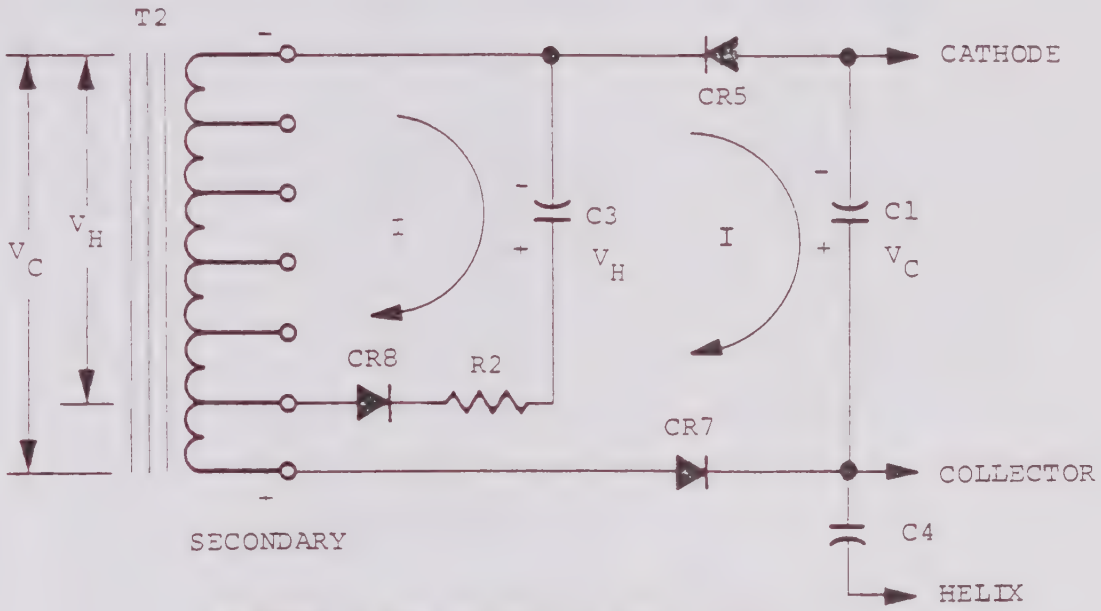


FIGURE 5-9A NEGATIVE HALF CYCLE

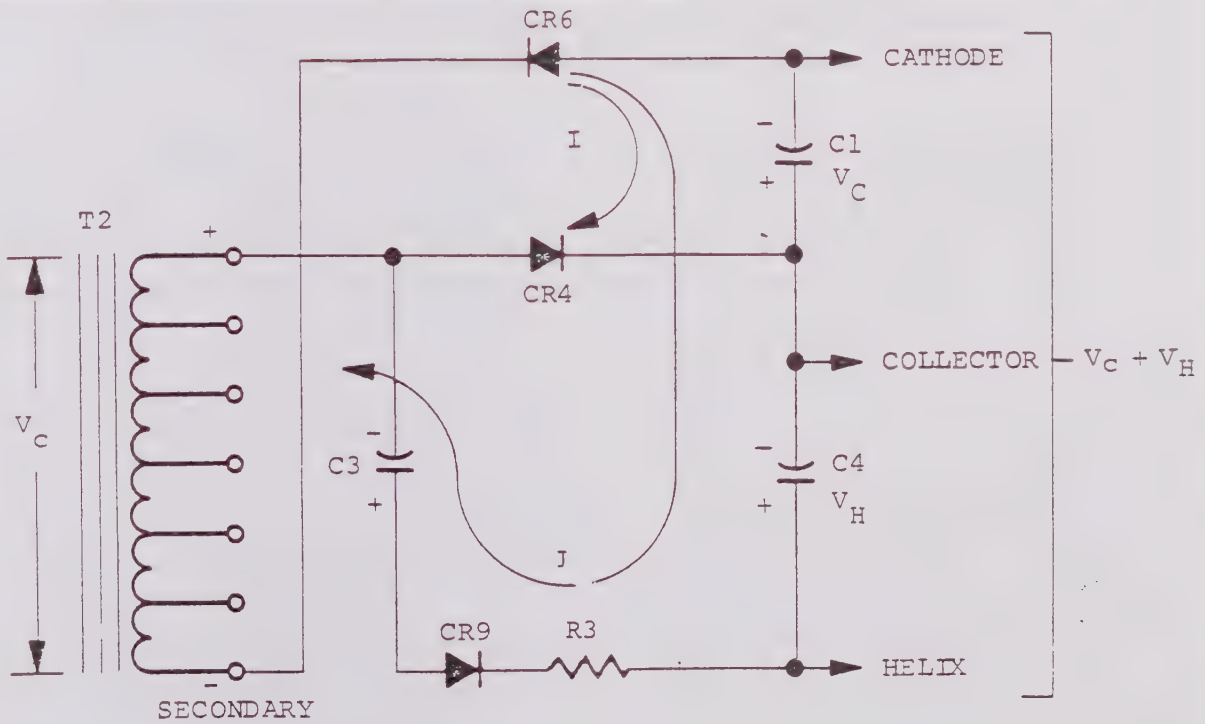


FIGURE 5-9B POSITIVE HALF CYCLE

C1 CHARGES TO V_C THROUGH CR5 and CR7 or CR4 and CR6

C3 CHARGES TO V_H THROUGH CR8 AND R2

C4 CHARGES TO V_H THROUGH CR6, C1, CR9 AND R3

FIGURE 5-9 HELIX AND COLLECTOR RECTIFIER CIRCUIT OPERATION

for C2, C5 and C3, C6. L1, C2, C3, C5, C6 in conjunction with C1 and C4 form a Pi filter to remove the 10 Hz, 20 kHz, and higher frequency ripple components.

5.2.6.6 Helix Current/Voltage Sense and Fault Protection. These circuits, Figure 5-10, are designed to allow metering and fault detection to occur at low potentials with respect to chassis ground to avoid danger to personnel or equipment. The diode pair CR4, CR5 clamp M1 to 700 mV max. In the event of a short circuit or arc of the high voltage to ground. The voltage between the junction of $9/R10 and ground is proportional to helix current and this is fed via feed-through connections on several boards to the detection circuit on the logic board A3 (1A3U7-2).

R2 thru R6 along with CR2 form the bleeder circuit for both helix and collector supplies. In addition they form a helix voltage sense string at J4-6 which is fed to the input of switch regulator feed back amplifier 1A3A3 to regulate the helix voltage.

Terminals are provided to short out R3, R4, R5 or R6 if needed for a coarse helix voltage adjustment. See Section 6, Table 6-5 for the connections required for your TWT. See Section 5.2.4 for further discussions of helix regulation by the switch regulator.

Zener CR2 will conduct at voltages in excess of 200 volts and prevents the Helix voltage sense line from floating at cathode potential when the sense line is unterminated. RV1 limits helix current sense resistor voltage to 200 V during arcs. C7 attenuates spikes and noise on the helix sense circuit. CR3 and R9 limit the output voltage of the helix sense circuit at J4-8 to 100 V during arcs. CR1 connects the collector supply to the bleeder string (R2-R6 thru CR2) when power is removed.

5.2.7 Logic PWB

5.2.7.1 General. The logic circuits provide the control, monitoring and protection of the TWTA. A functional block diagram of the Logic PWB is presented in Figure 5-11.

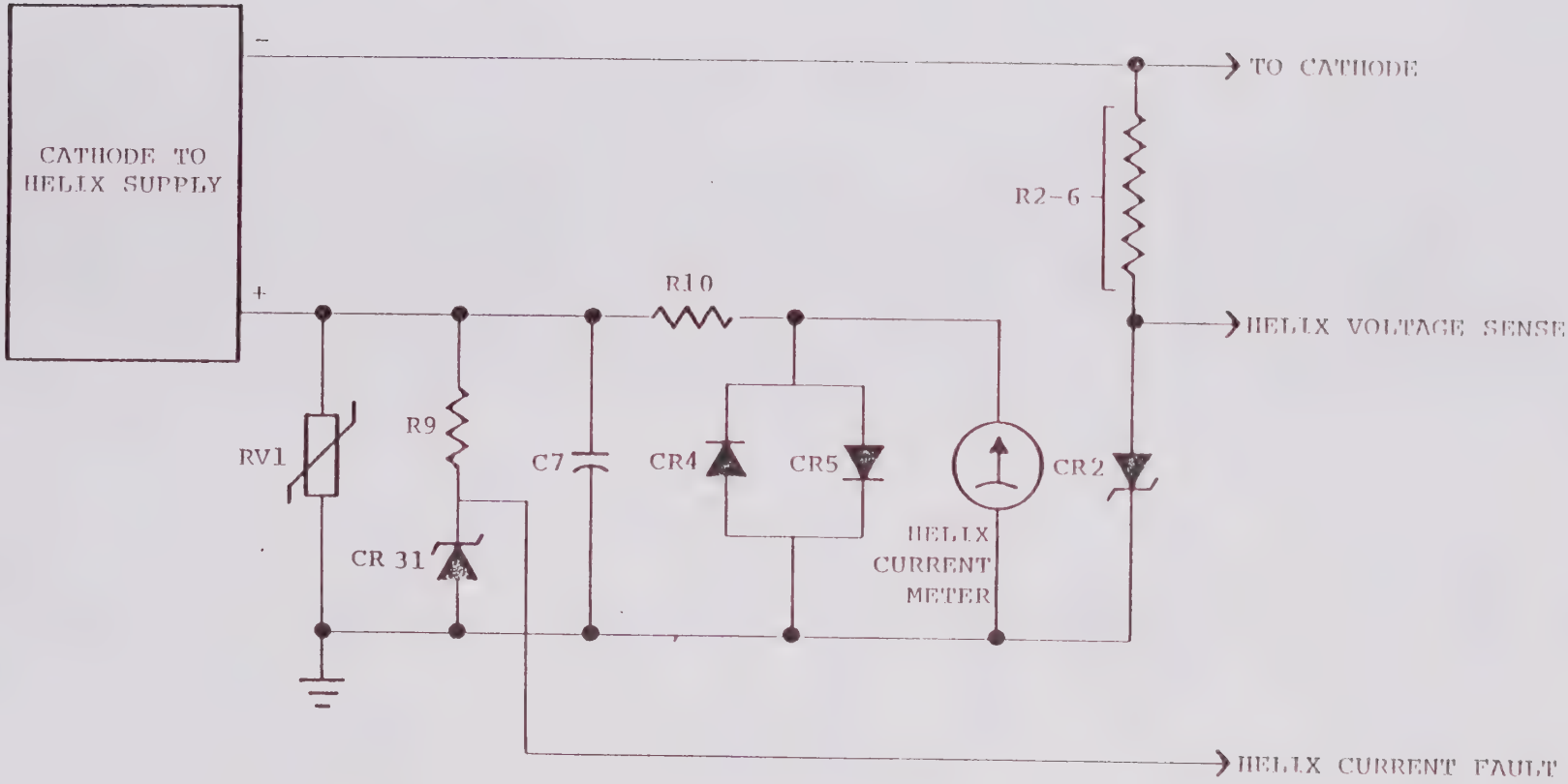


FIGURE 5-10 HELIX CURRENT, VOLTAGE SENSE AND FAULT PROTECTION

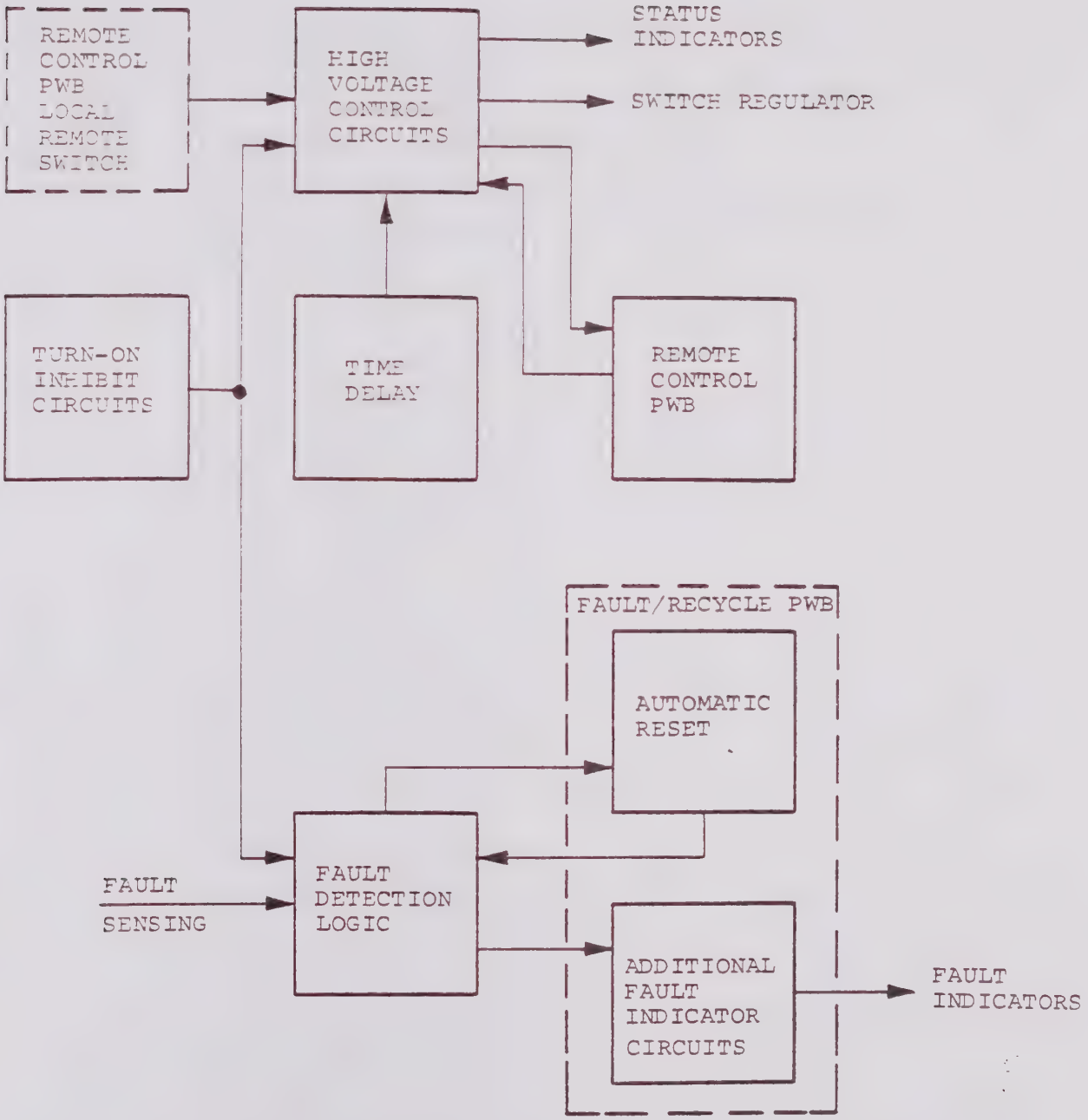


FIGURE 5-11 LOGIC PWB FUNCTIONS

NOTE

Incorporation of the Fault/Recycle PWB option is required for operation in the AUTO RESET mode. Check Section 1, Table 1-1 to determine if your TWTA includes this option.

5.2.7.2 High Voltage Control. The High Voltage Control circuits are shown in Figure 5-12.

NOTE

Figure 5-12 includes the circuits for the Remote Control Option. Check Section 1, Table 1-1, to determine in your TWTA includes this option.

The output of U9A must be a logic low (0) to turn on the high voltage power supply. U9A drives Q4 through U2A which enables 1A3U2 on Switch Regulator PWB A3 and allows the Schmitt trigger to operate. U9A also drives Q8 through U2D which provides an enable signal for the -200 Vdc undervoltage protection circuit on oscillator bias PWB A2.

Without the Remote Control option installed, U10A-3 is jumpered (Jumper 4) to common and U10A13 always remains high. U12C bilateral switch "contacts" pins 8 and 9 are closed by a "1" state at U12C-6. Pins 1 and 2 are opened by a "0" state at U12C-13. This means that high voltage can only be turned on by a "0" at U10C-15 causing U10C-1 to switch to a "1" which drives U9A-2 high through U12C.

With the remote control board installed, when the "local" position of the local/remote switch is selected, operation is the same as described above. In the "remote" position, U10A-13 will be "0", U6C-6 will be "1". This closes contact pins 1 and 2 of "switch" U12C and opens contact pins 8 and 9. High voltage can only be turned on by a "0" at U10B-7 causing U10B-9 to switch to a "1" which drives

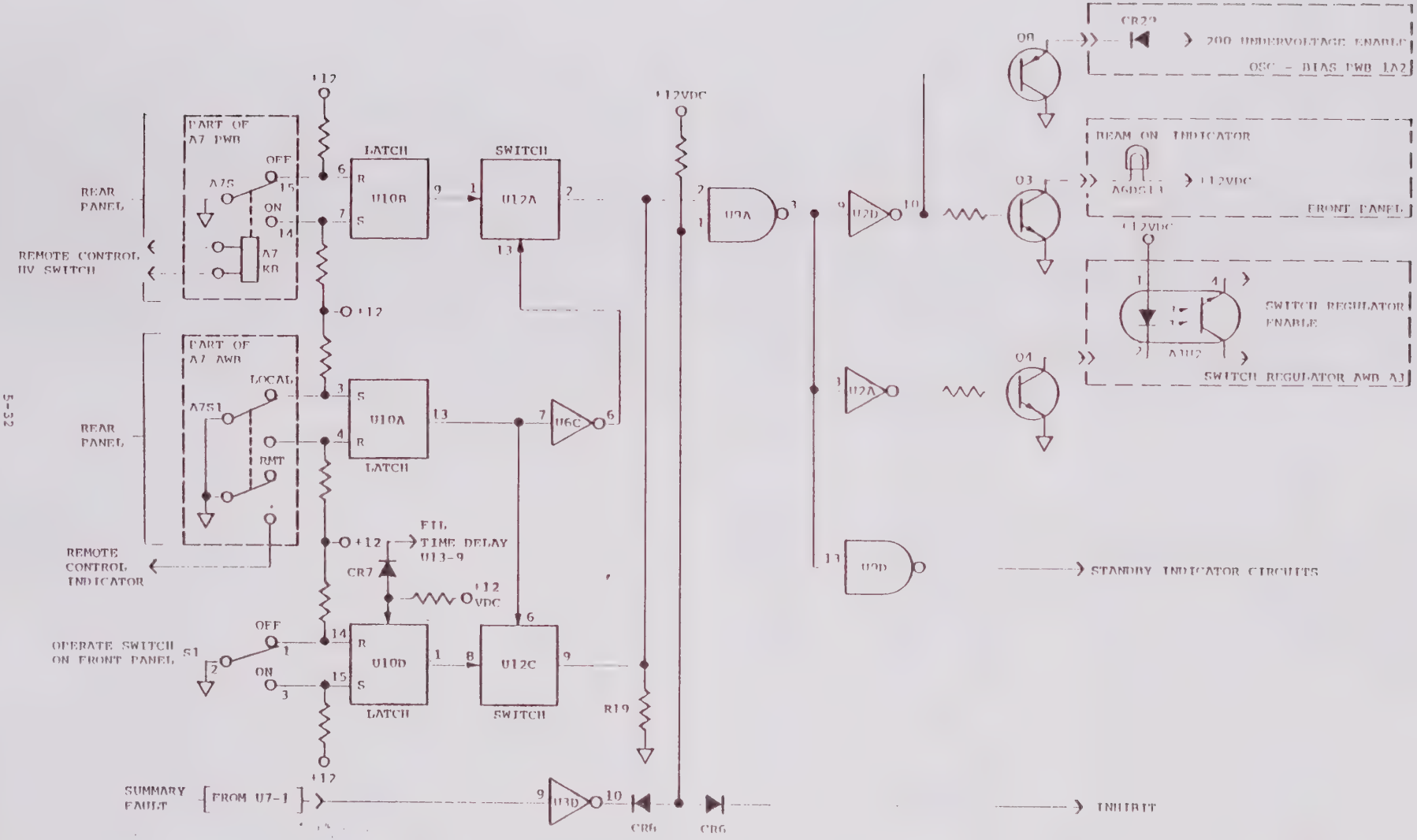


FIGURE 5-12 SIMPLIFIED SCHEMATIC-HIGH VOLTAGE CONTROL

NOTE: NOT ALL CIRCUIT COMPONENTS SHOWN. SEE A1 SCHEMATIC FOR DETAILS.

U9A-2 high through switch U12A. Actuation of relay 1A7K8 of Remote Control PWB A7 by closing a remote switch to ground pulls U10B-7 to a logic low (0) state. When U9A-2 is in the "1" state, HV ON has been selected. If there is no fault, U9A-1 will be "1" and HV will be turned on to the TWT and "BEAM ON" will light on the Front Panel and give a remote status indication. The logic state associated with high voltage control for different input conditions is shown in Figure 5-13.

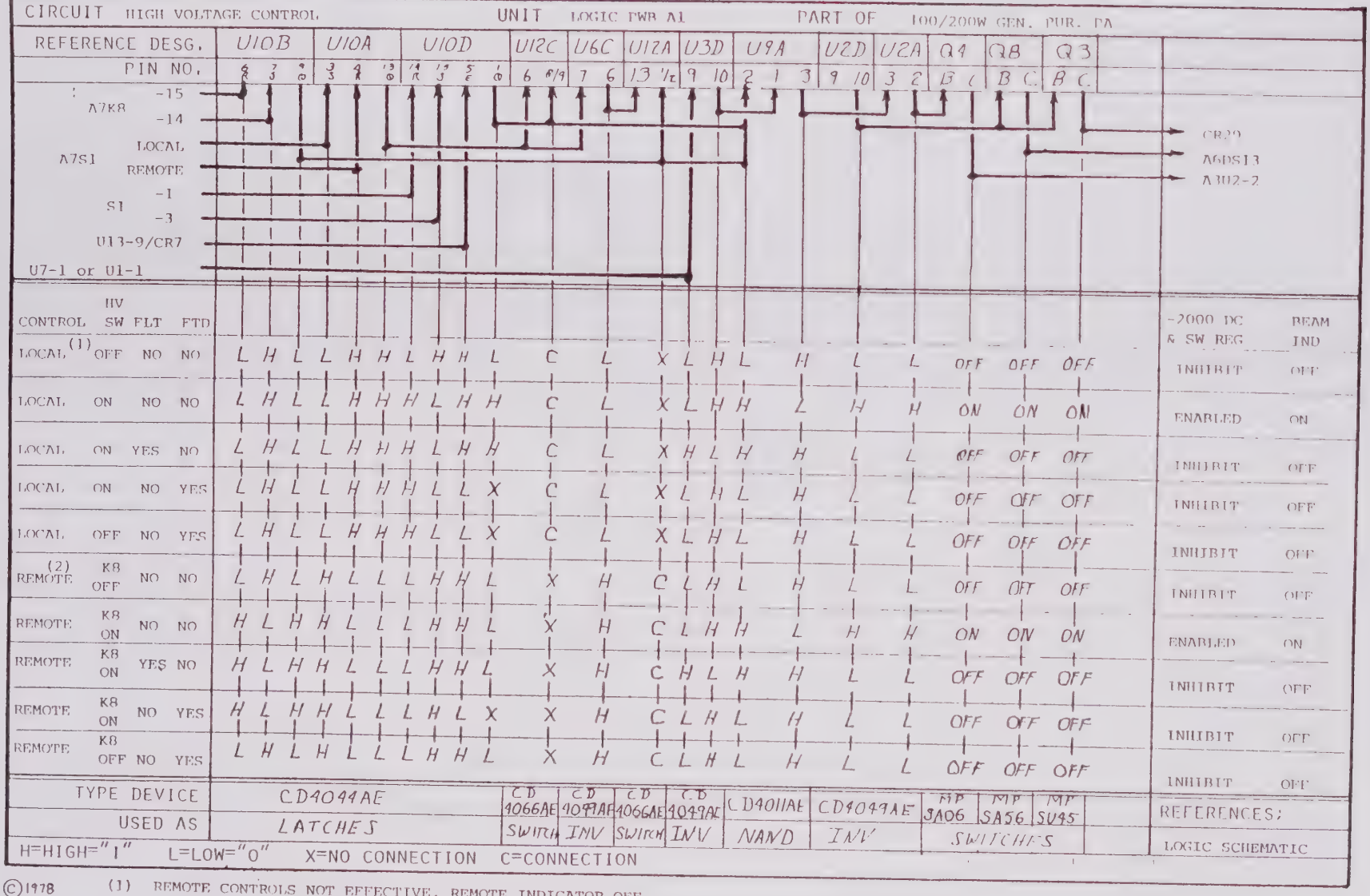
5.2.7.3 Filament Time Delay. This circuit inhibits High Voltage turn-on until the TWT filament reaches the proper temperature (approximately 3 minutes delay) and provides immunity against unnecessary time delay recycling during transient prime power interrupts (order of a few seconds).

A simplified schematic of the circuit is presented in Figure 5-14. Schematic details are given in the A1 schematic in Section 7.

The focal point for operation of this circuit is the voltage charge on capacitor C28. U13 includes a circuit (A) that prevents C28 from charging until U13 is triggered on by a positive going voltage applied to pin 2. Pin 2 is tied to +12VDC so that when TWTA power is turned on the FTD circuit is triggered on. When U13 is triggered on and 12 VDC is applied to R57, C28 charges at a rate set by R57, R58, C28. The values are chosen so that the voltage on C28 is approximately 1.18 volts in 3 minutes. U13 includes an internal voltage reference (B) that applies 1.18VDC to one side of an internal comparator (C). When C28 is charged to 1.18 volts, the output transistor (D) is turned off and pin 9 changes from a logic low state to a logic high.

When the +12 VDC supply voltage is interrupted C28 can discharge through R59, CR9, R40 and R60. U14 acts like a switch across R59, CR9. When the 12 volt supply is first interrupted there is sufficient residual charge to hold U14 on so that C28 would discharge with a time constant of about 1.2 seconds. As the 12 volt supply continues

FIGURE 5-13 COMPOSITE PRESENTATION OF SIGNAL PATHS AND LOGIC STATES



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(1) REMOTE CONTROLS NOT EFFECTIVE, REMOTE INDICATOR OFF.

(2) FRONT PANEL HIGH VOLTAGE SWITCH NOT EFFECTIVE, CONTROL THROUGH A7K8, REMOTE INDICATOR ON.

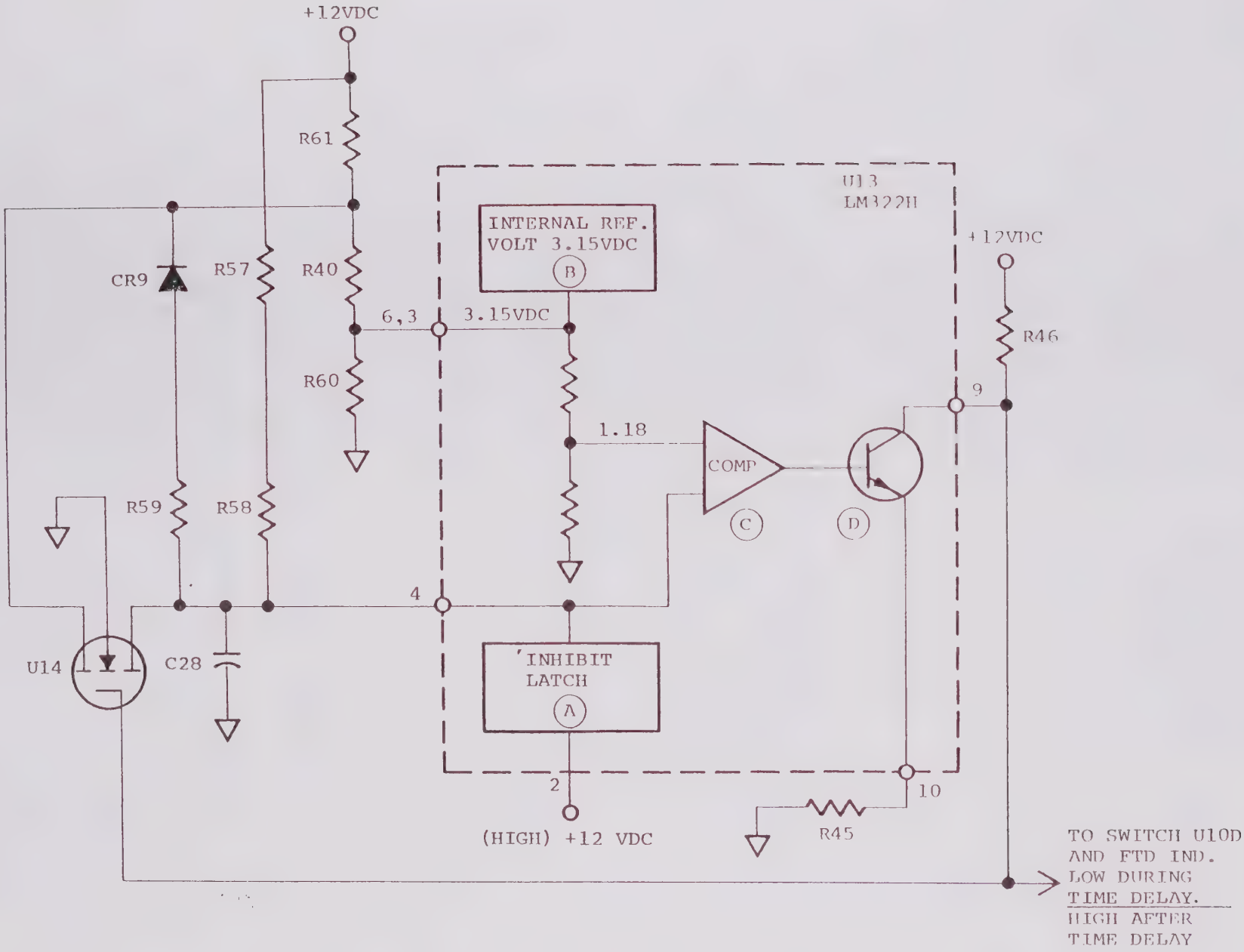


FIGURE 5-14 SIMPLIFIED SCHEMATIC DIAGRAM — FILAMENT TIME DELAY

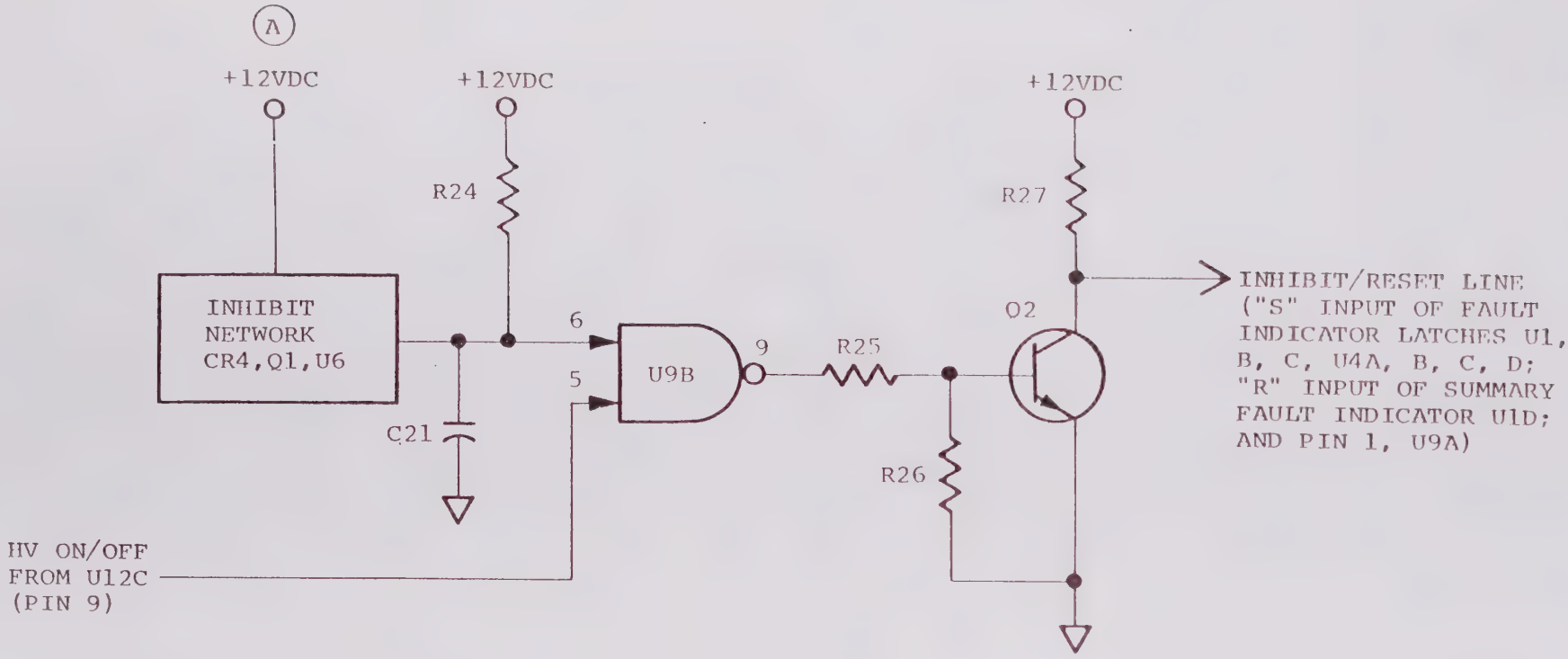
to discharge, U14 turns off and the time constant for discharge of C28 increases to about 10 seconds. The purpose of the immunity circuit is to hold the charge on C28 high enough that for very short interruptions (1-2 seconds) there will be no delays for filament heating and for longer periods the time delay will be approximately proportional to the length of time the power is off. The filament time delay circuit will recycle completely if power is interrupted for more than about 90 seconds and there will be no recycling action for interrupts of 2 seconds or less.

NOTE

This TWTA is equipped with fast response fault detection circuits. If you "flip" the OPERATE/OFF/RESET switch from OPERATE to OFF/RESET and back again you may induce faults. When you turn the BEAM OFF wait 1 second before returning to OPERATE again. If there is a fault indication after a very short prime power interruption, this is normal and the Fault Recycle and Indicator PWB A8 will automatically clear such faults.

5.2.7.4 Inhibit/Reset Circuits. A functional diagram of the Inhibit/Reset Circuits is presented in Figure 5-15. The functions of these circuits are:

a. Inhibit of summary fault and HV ON until +12 VDC logic supply voltage reaches a value in excess of 9.8 volts.
b. Inhibit operation of summary fault indicator in HV "OFF" mode.
c. Reset fault indicators when HV "OFF" conduction is selected.



TRUTH TABLE

DEVICE REF DESG	U9		Q2		
CONDITION	6	5	BASE	COLLECTOR	RESULT
INITIAL TURN-ON A LESS THAN 9.8 VOLTS	LOW	LOW	HIGH	LOW	INHIBIT & RESET
A GREATER THAN 9.8 V HV OFF	HIGH	LOW	HIGH	LOW	INHIBIT REMOVED
A 9.8 VDC HV ON	HIGH	HIGH	LOW	HIGH	INHIBIT & RESET

FIGURE 5-15 FUNCTIONAL DIAGRAM - FAULT INHIBIT/RESET

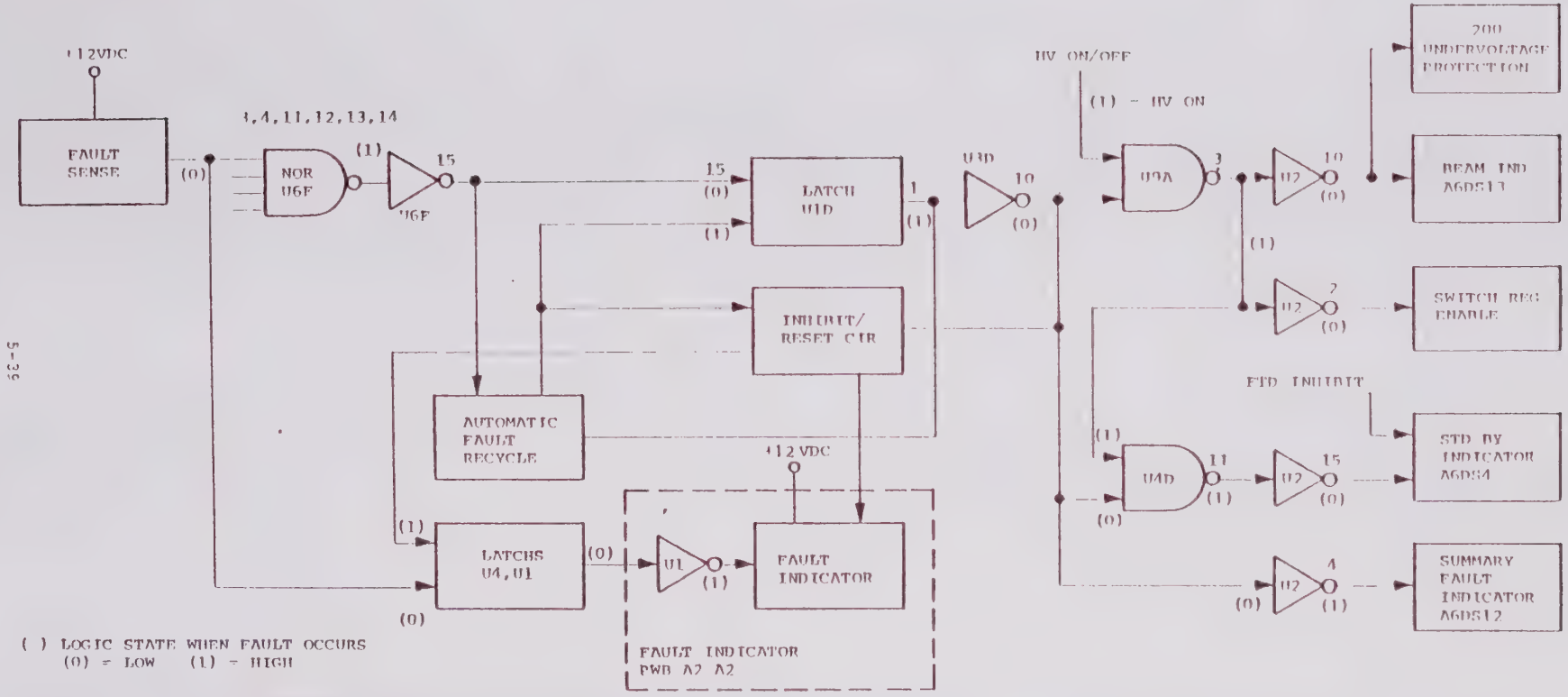
The circuits consist of an inhibit network that operates during initial logic power turn-on and a NAND logic circuit that drives the affected devices. The inhibit network holds C21 low until the +12 VDC bus voltage exceeds 9.8 Vdc. Referring to the A1 logic schematic in Section 7, transistor Q1 is off at initial turn-on and the input to inverter U6E (pin 11) is high. This pulls C21 low through R23 and CR5. When the +12VDC bus voltage reaches about 9.8 Vdc, zener CR4 will conduct which turns Q1 on. This drives U6E12 high and allows C21 to charge up to +12 VDC in about 0.1 second. When C21 is fully charged and U12C-9 is high (HV ON command), NAND gate U9B-9 will go low which turns Q2 off driving the collector of Q2 high. The truth table in Figure 5-15 indicates the operation of the logic circuit. Note that a HV OFF command will produce the same inhibit/reset conditions as exist at initial turn-on even though C21 is fully charged.

5.2.7.5 Fault Detection Logic and Indicators. The Fault Detection Logic and Indicators are part of the overall safety and protection features built into the Power Amplifier. A functional diagram of the Fault Detection Logic and Indicators is shown in Figure 5-16.

The function of the Fault Detection Circuits is to turn high voltage off when a fault occurs and to indicate the area where the fault occurred. Schematic details are contained in the drawings referenced in Figure 5-16 which are included in Section 7 of this manual. As shown in Figure 5-16, the output of the fault sensing circuits branches along two parallel logic paths. The upper path involving U6F, U1D, U9A controls operation of the High Voltage Beam Supply, the automatic fault recycle circuits and some of the operational indicators. The lower path involving latches U1 and U4 and the fault/recycle PWB indicates the function that initiated the fault signal. The logic state for a fault that occurs when HV is ON and there is no inhibit/reset output is given in Figure 5-16. A more comprehensive set of signal paths and logic states are presented in Figure 5-17. In Figure 5-17, example faults were applied to pin 3 of U5. Since U5 is a NOR, a fault on any one of the fault inputs to U5 (3,4,11,12, 13,14) will produce the same result. Note that any time there is a

LATCH TRUTH TABLE

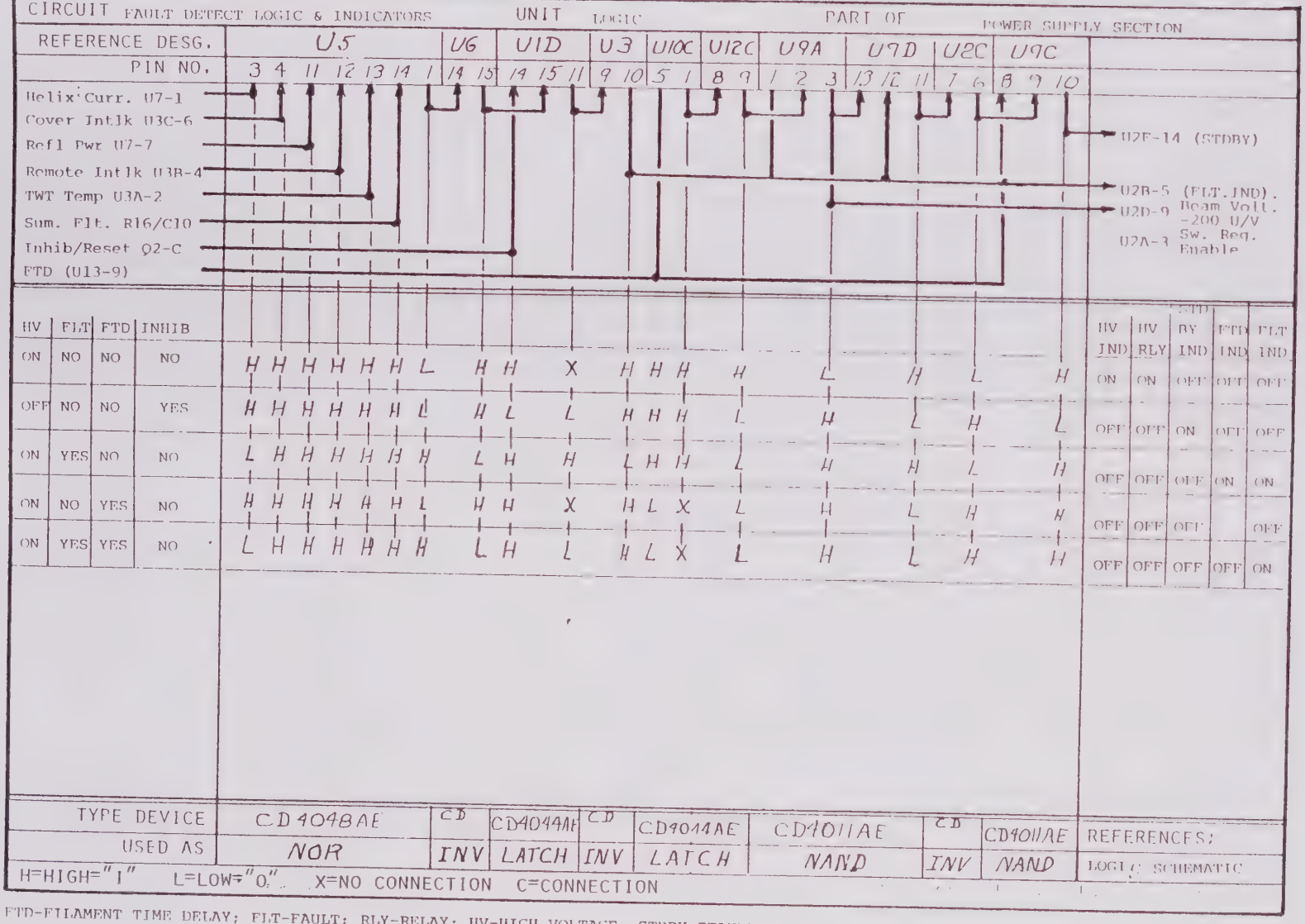
S	R	O
0	0	0
0	1	1
1	0	0
1	1	NC (X)



REFERENCE: A1 (LOGIC) SCHEMATIC, UD1 (OVERALL) SCHEMATIC

FIGURE 5-16 FUNCTIONAL BLOCK DIAGRAM-FAULT DETECTION LOGIC AND INDICATOR

FIGURE 5-17 (WITHOUT FAULT RECYCLE OPTION) COMPOSITE PRESENTATION OF SIGNAL PATHS AND LOGIC STATES



FTD-FILAMENT TIME DELAY; FLT-FAULT; RLY-RELAY; HV-HIGH VOLTAGE; STDBY-STANDBY

High Voltage OFF command from the central panel switch, Q2 of the inhibit/reset circuit (section 3.3.4) will be on and the output of U1D (pin 1) will be low. This will prevent the summary fault indicator A6DS12 from being turned on. During the Filament Time Delay period the same condition will exist.

See Section 5.2 for a discussion of the Fault/Recycle PWB option. The operationsof the various fault logic circuitry are follows:

a. Helix Current Fault - Helix current is sensed by the voltage developed across a resistor in the HV module. The input voltage is approximately 0.1 Vdc/mA. If the current drawn by the helix is excessive, the voltage at amplifier U7A-2 (LM358N) will be higher than the reference voltage at U7A-3 (adjustable by R3). If this happens, U7A-1 will switch to "0" signaling a fault. During turn-on of HV, the helix will always draw more current due to beam defocusing. For this reason, R1 and C29 provide a short immunity time delay before an actual fault is signaled.

b. Reflected Power Fault (VSWR) - If a reflected power shutdown option has been included, the RF reflected power will be monitored by a diode detector. Input voltage is in the range of +50 to +150 mVdc. If the U7B-6 (diode voltage output) is higher than the reference voltage at U7B-5 (adjustable by R6), then U7B-7 will switch to "0" signaling a fault. R4 and C30 provide a short immunity time before an actual fault is signaled.

c. Interlock Faults - If the top or bottom cover is removed, interlock switch contacts on the top or bottom of the chassis will open. This will put a logic "1" on U3C-7, U3C-6 will switch to "0" and a fault is signaled.

d. Remote Interlock - If there is no Remote Control option installed, jumper 5 will keep U3-5 low, and no remote interlock fault can be signaled. If a Remote Control option is installed, U3B-5 will be connected to common via the Remote Control unit if a remote fault is signaled.

e. Temperature Switch - If the TWT temperature exceeds approximately 110°C at the TWT heatsink, the thermal switch will open putting a logic "1" on U3A-3, U3A-2 will switch to "0" and a fault is signaled.

f. Power Supply Fault - J4 pin 4 is a summary power supply fault signal. Normally this voltage will be "1". If any fault from the converter, switch regulator or oscillator bias card is present, the voltage at R16 will change to "0" and a fault is signaled.

All faults are connected to U5, and when any input to U5 goes to "0", U5-1 switches to "1", U6F-15 switches to "0" and U1D-15 has a "0" applied. This "0" causes an immediate HV shutdown, and a "fault" indication will light on the Front Panel. When the HV switch is switched off, gate U11 will provide a short pulse to Q9, resetting any power supply summary fault.

The logic for the specific fault indicators such as External Interlock is straightforward. A fault on any of the input lined drives the input to NOR U5 low, at the same time the R input to the indicator latches is driven low. Note that while the same type of latch is used for the summary fault circuit, the inputs are the reverse of those used for the specific fault indicators. Referring to the latch truth table in Figure 5-16, when the R input is low and S high, the latch output will be low. This output is inverted and turns on the transistors (A2A2Q1 through Q6) for the proper channel. If the fault persists, the output would remain low and the indicator stay lit even though the inhibit/reset circuit pulls the S input low. If the fault is removed, pulling the S input low would reset the latch and turn off the specific fault light.

5.2.7.6 TWTA Status Indicator Logic Circuits. These circuits and the interface of these circuits with the control and fault logic are shown in Figure 5-16. These circuits drive the Status Indication Display Module A6 which is mounted in the Front Panel, and the appropriate relays on the Remote Control Panel PWB A7. A low on the input to any one of inverters U2A,B,D,E and F causes the coupled U2 output to go high which turns on Q3,4,5,6 and 7 as appropriate. During the time-out period U9C-8 is held low which drives U2F-14 high. Therefore, either the TIME DELAY or STANDBY indicators are illuminated. After time out, a high voltage ON command will drive U9A-3 low causing U9D-11 to go high and U2C-6 to go low which drives U9C-10 high. This will extinguish the STANDBY indication by turning Q6 OFF. A fault will drive U3D-10 low and turn on Q7 which will illuminate the FAULT indicator and inhibit the STANDBY indicator through U9D to U2C to U9C to U2F to Q6.

5.2.8 Fault/Recycle PWB A8

5.2.8.1 General. The Fault/Recycle PWB provides functions that enhance both operation and troubleshooting of the TWTA. The unit will activate additional fault indicators as follows:

a.	Helix Current Fault	(HELIX CURR)
b.	Reflected Power (VSWR) Fault	(REFL RF)
c.	Cover Interlock Fault	(COVER INTLK)
d.	Remote Interlock Fault	(EXT INTLK)
e.	TWT Overtemperature Fault	(OVER TEMP)
f.	Power Supply Fault	(POWER SPLY)

Any fault turns the "STANDBY" light on, the type of fault will be displayed, and three attempts will be made to restore operation. If, after the third attempt normal operation is not restored, then the "FAULT" light will go on and "STANDBY" will go out. If the fault was of a temporary nature, such as a "REFL RF" and the fault is removed, the "BEAM ON" will light. However, the "REFL RF" indication light will remain until reset with the OPERATE/OFF/RESET switch.

5.2.8.2 Fault Indication Drive Circuits. These circuits are presented in Figure 5-16 and the A1 schematic. The fault detection logic drives one of the inputs to 1A1U5 (U5-3, 4, 11, 12, 13, 14) in parallel with one of the inputs to 1A1U4 and U1 (U1-6, 12, U4-4, 6, 12, 14). 1A1U4 and 1A1U1 operate in accordance with the Truth Table presented below:

TRUTH TABLE FOR A1U4/U1
(CD4044AE) (Pin 5 High)

S	R	Q	
0	0	0	0 = low
0	1	1	1 = high
1	0	0	
1	1	No change	

At initial turn-on the "S" input to latches u1B, C and U4A, B, C, D, are driven low by the Inhibit/Reset Circuit and the "R" input (with no faults) are high. This sets the Q output of these latches high and the specific fault indicators will be off. After initial turn-on, the "S" input is allowed to go high and the output of the latches remain high. When a fault occurs, this drives the "R" input to the specific fault indicator latches low which then turns the indicator transistor (Q1 through Q6) on via the appropriate U1 inverter. Each time the OPERATE/OFF/RESET switch is placed in the OFF/RESET position, the indicator latch will be reset if there is no fault. If there is a fault on one of the inputs, the indicator will stay on until the fault has been cleared.

5.2.8.3 Automatic Fault Recycling Circuits. The fault recycle circuits are designed to count the number of faults that occur in a 20 second interval. If four faults occur during the 20 second interval, high voltage operation will be inhibited and operator action required to clear the fault. If the circuit detects 3 or less faults during the 20 second interval, the circuits will automatically recycle and reset the fault detection circuits.

A functional block diagram of the automatic fault recycle circuits is presented in Figure 5-18. The circuit works the same for a continuous fault or for discrete faults that occur at different points in time. When a fault occurs the output of U6F-15 is driven low from its normally "high" state. This trips two latches (A8U4A, A8U4D) in addition to A1U1D. The sequence of recycling events is shown in Figure 5-19.

The time relationship of the operation of the recycling sequence is also presented in Figure 5-19. There are two timers incorporated into the circuit, 20 second interval timer (U5) and a 1.2 second recycle timer (U2A). A fault counter, U2B, is also incorporated in conjunction with a reset inhibit circuit. A single discrete fault indication on U6F-15 will initiate operation of both timers and increment the fault counter. Both timers are driven by a 7 Hz clock, U6B. U5 will reset the fault counter after 20 seconds if less than four faults has occurred during the 20 second interval. At the same time U4D will also be reset. If four faults have occurred the reset inhibit circuit, which consists of U3B, U4B, U3D, will inhibit reset of U2B through N and U7C by placing a low on pin 9 of U7C which forces the output of U7C high. The output of U7C is connected to the reset input of U2B (pin 15) via inverters U3A. As long as latch U4D of the reset inhibit circuit signals four faults, operation of the high voltage supply will be inhibited because U3D is connected to U7D which connects to the high voltage control circuits through A1U3D and A1U9A.

The fault counter is incremented by the output of latch U4A. The same output resets recycle timer (U2A). The recycle timer will generate a reset signal for this system about 1.2 seconds after the output of latch U4A goes high and initiates operation of U2A through U2A-2 and inverter U3C. The system reset pulse is generated when U2A-6 goes high. This signal is inverted by U7B pulling the system reset line low through diode CR1. The output on U2A-6 also connects to N and U7A. Coincidence of a clock pulse from U6B and a high on U2A-6 resets latch U4A and the circuit is ready for actuation by another fault.

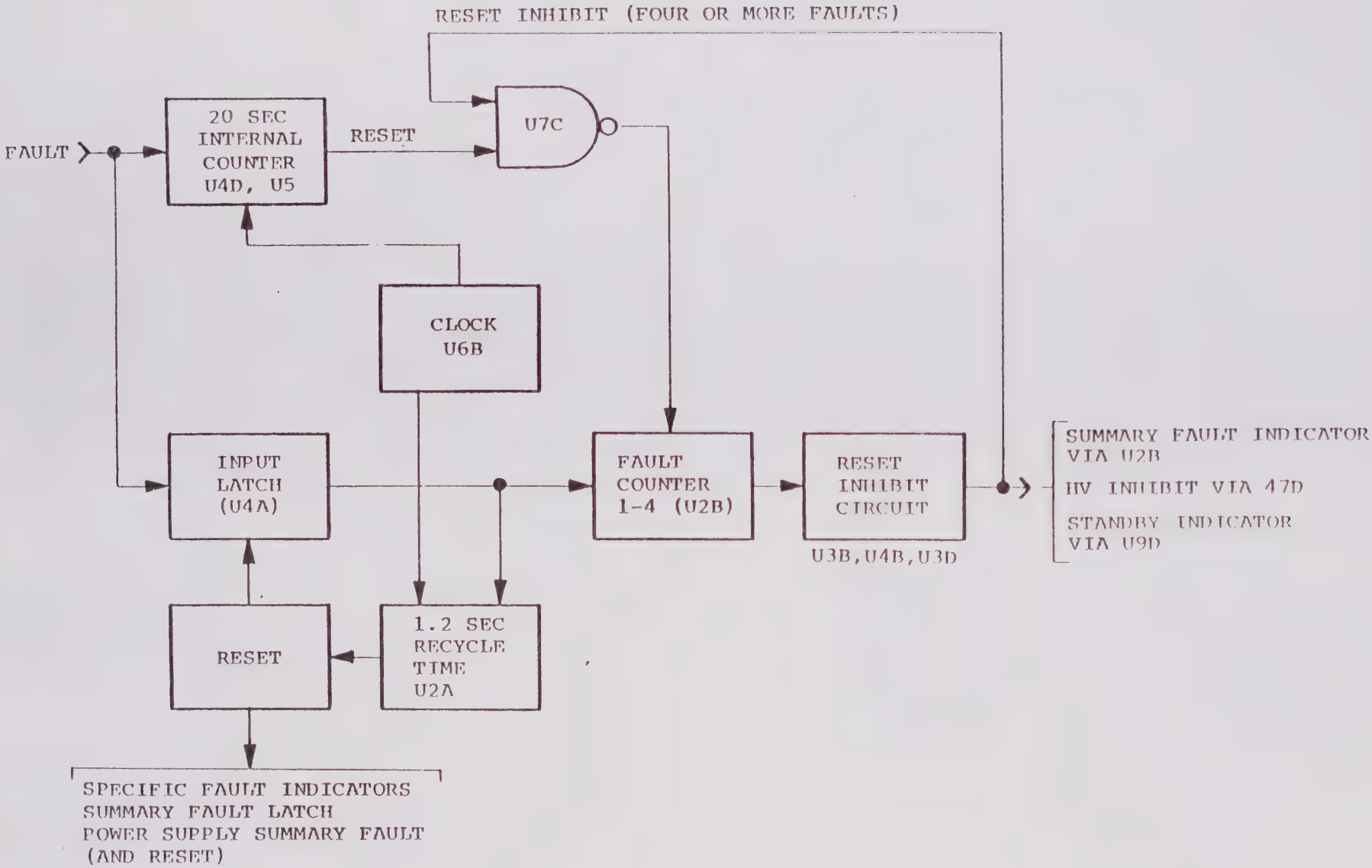
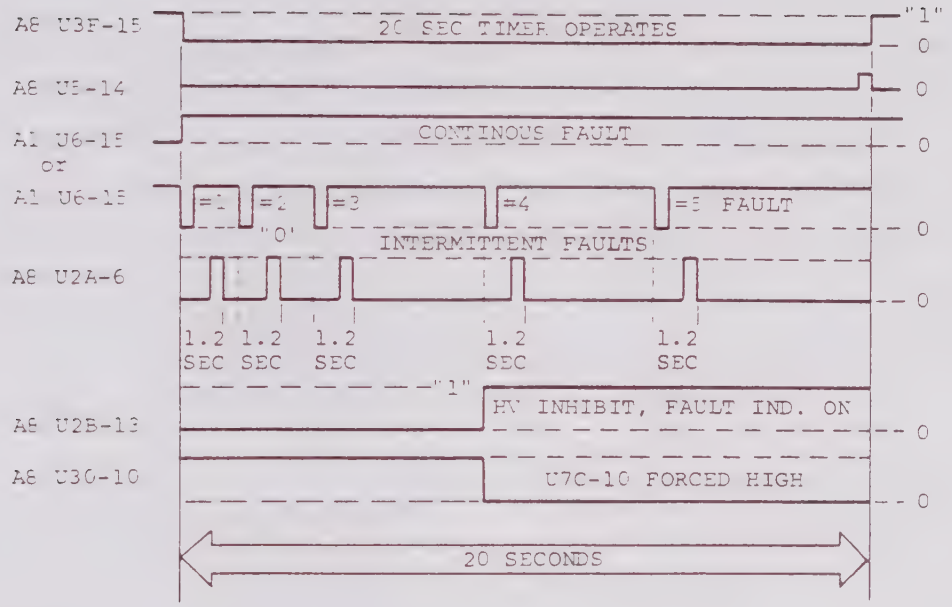


FIGURE 5-18 FUNCTIONAL BLOCK DIAGRAM - AUTOMATIC FAULT RECYCLING CIRCUITS

TIMING



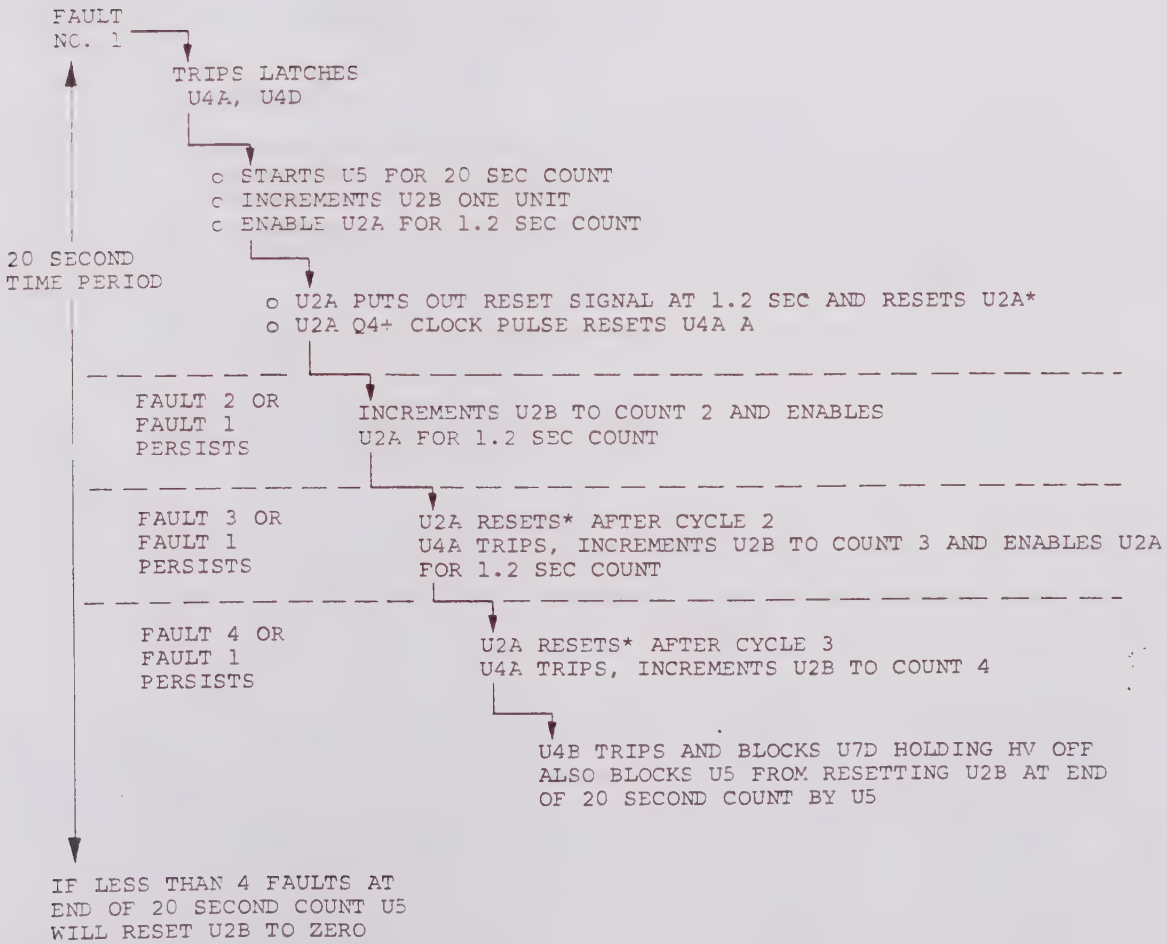


FIGURE 5-19 AUTOMATIC FAULT RECYCLING CIRCUITS-SEQUENCE OF EVENTS AND TIMING RELATIONSHIP

Multiple faults that occur within the 1.2 second recycling period will not cause any action. A persistent fault that is present when the recycle timer drives U2A-6 high will immediately increment the fault counter one count and force a repeat of the recycle operation. As long as a fault is signaled on U4A-3 the recycle timer will continue to cycle and try to reset the system. As noted earlier on the fourth fault, the circuit latches into a high voltage inhibit, interval timer inhibit mode. Similarly, the 20 second interval timer will continue to cycle as long as there is a fault on the input to U4D.

The logic states of the various components at different points in the sequence are presented in Figure 5-20.

5.2.9 Status Indicator Display A6

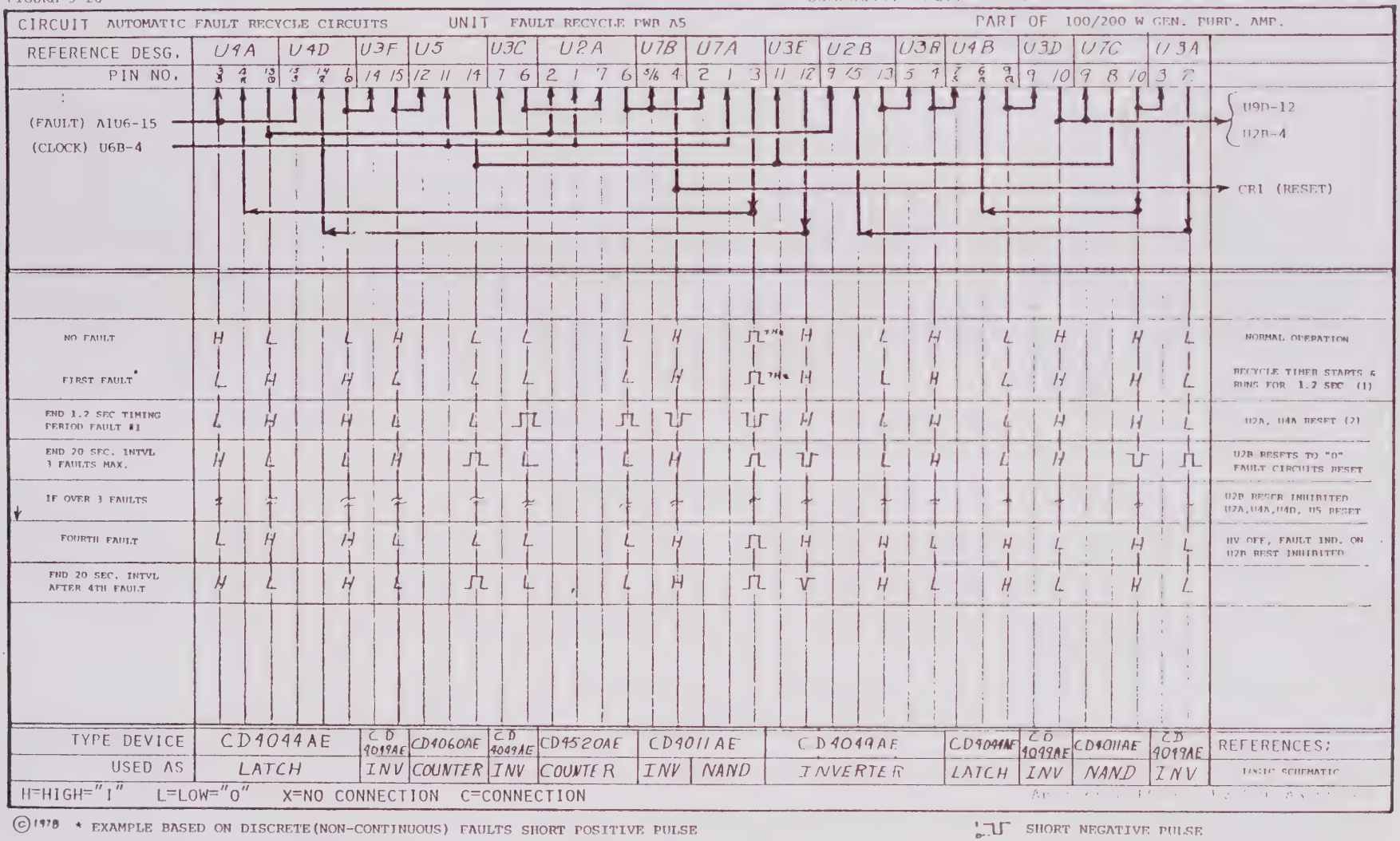
The format of the A6 unit is shown in Figure 5-21. A common 15 VDC buss is connected to terminal 10 (behind logo). Each indicator terminal is wired to an indicator driver, on either the logic or fault recycle PWB, that completes the path to the 15 VDC return and illuminates the display (see Section 5.2.7.6). The indicators are long life incandescent bulbs that are replaceable from the front panel.

5.2.10 Optional Remote Control PWB A7

The remote control option provides a means for either local or remote control of the high voltage, remote interlock, remote status indication for filament time delay (FTD), standby, high voltage on, and summary fault. (See Figure 3-2)

The remote control PWB schematic is in Section 7. The operation of the local/remote switching is discussed in Section 5.2.7.2. The remote indicators are actuated by form C relay contacts of relays K1, K2, K3, K4 and K6. When the appropriate circuit on logic board A1 is energized (see 5.2.7.6 and 5.2.8.2), the same transistors A1Q3, Q6, Q6, Q7 drive the local indicators and the appropriate remote control PWB relays which close the circuit through the relay contact for the remote status indication.

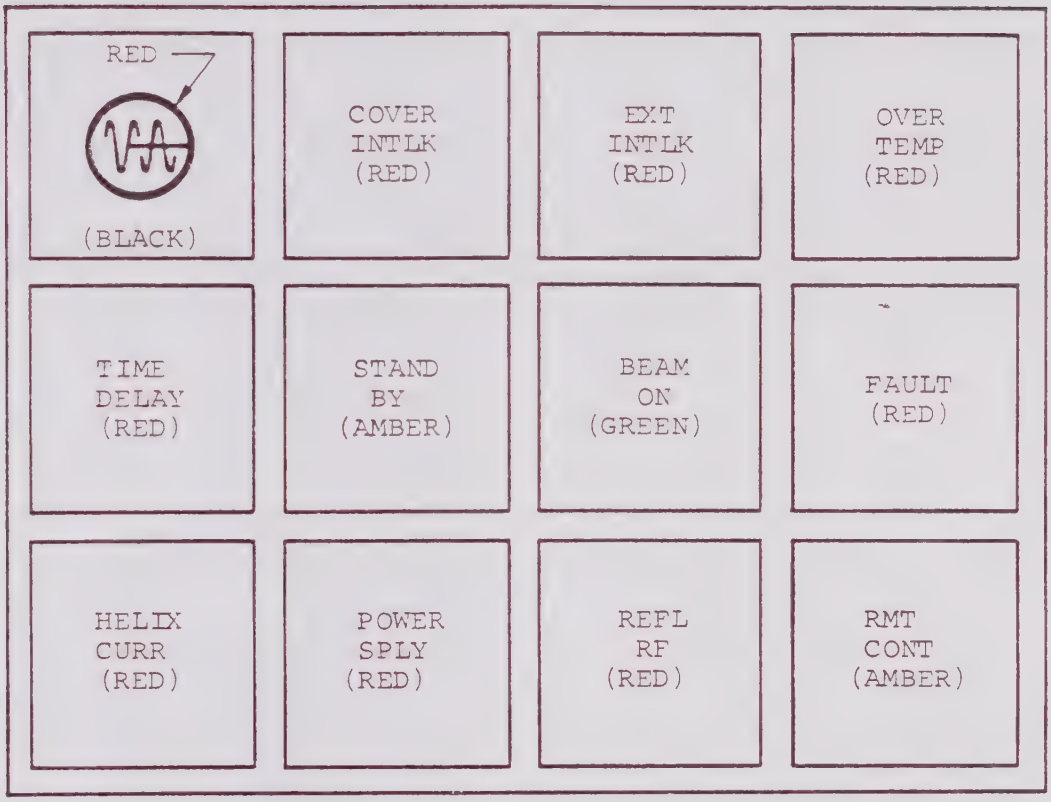
FIGURE 5-20 COMPOSITE PRESENTATION OF SIGNAL PATHS AND LOGIC STATES



©1978 * EXAMPLE BASED ON DISCRETE(NON-CONTINUOUS) FAULTS SHORT POSITIVE PULSE

SHORT NEGATIVE PULSE

(1) FAULT COUNTER U2B INCREMENTS 1 UNIT. INTERNAL TIMER U5 STARTS 20 SEC. COUNT.
(2) FAULT COUNTER U2B INCREMENT 1 UNIT EACH IF 2ND AND 3RD FAULT OCCURS.



ALL CHARACTERS BLACK EXCEPT LOGO WHICH IS RED
( ) COLOR OF BACKGROUND WHEN ILLUMINATED
RATED: VOLTAGE 14 VDC, CURRENT 200 ma
AVG. BRIGHTNESS 220 FOOT LAMBERTS

FIGURE 5-21 STATUS INDICATOR DISPLAY A6

The control inputs are High Voltage ON and OFF and an external interlock circuit.

Relays 1A6K6 and 1A6K8 are used for control purposes. Form C contacts actuated by these relays provide the internal TWTA signals. The relays provide isolation in between the internal logic and the external command lines. A customer supplied switch is connected between the relay and the 12 VDC return line. Closing the switch actuates these relays which then controls the TWTA operation.

5.3 RF SECTION

5.3.1 General

A wide variety of RF configurations, options, and special features are available. See the Special Features section of this manual for further discussion of the RF Section. Some general information on the operation of the TWTs used in the 100/200 watt series is presented in Section 5.3.2.

5.3.2 General Discussion of TWT Operation

A sketch of a basic helix traveling wave tube is shown in Figure 5-22. TWTs operate in the following manner: Electrons are emitted by the cathode and are accelerated down the center of the helix by the helix to cathode potential. Here they interact with the RF input signal traveling down the helix at approximately the same speed as the electron beam through the helix. This interaction between the electron beam and the RF wave results in a transfer of energy from the beam to the helix RF wave. Upon traversing the length of the helix the electrons (now travelling somewhat slower due to the energy given to the RF wave) strike the collector and are returned to the power supply. The process of continual interaction between the radio frequency wave on the helix and the electron beam results is an RF amplifying device without many of the gain bandwidth limitations of ordinary electron tubes.

The TWT will operate properly within a relatively limited range of helix voltage. This voltage must be well regulated and filtered to avoid injecting spurious outputs onto the RF wave.

5.3.3 Optional High VSWR Protection

Two forms of optional protection are available:

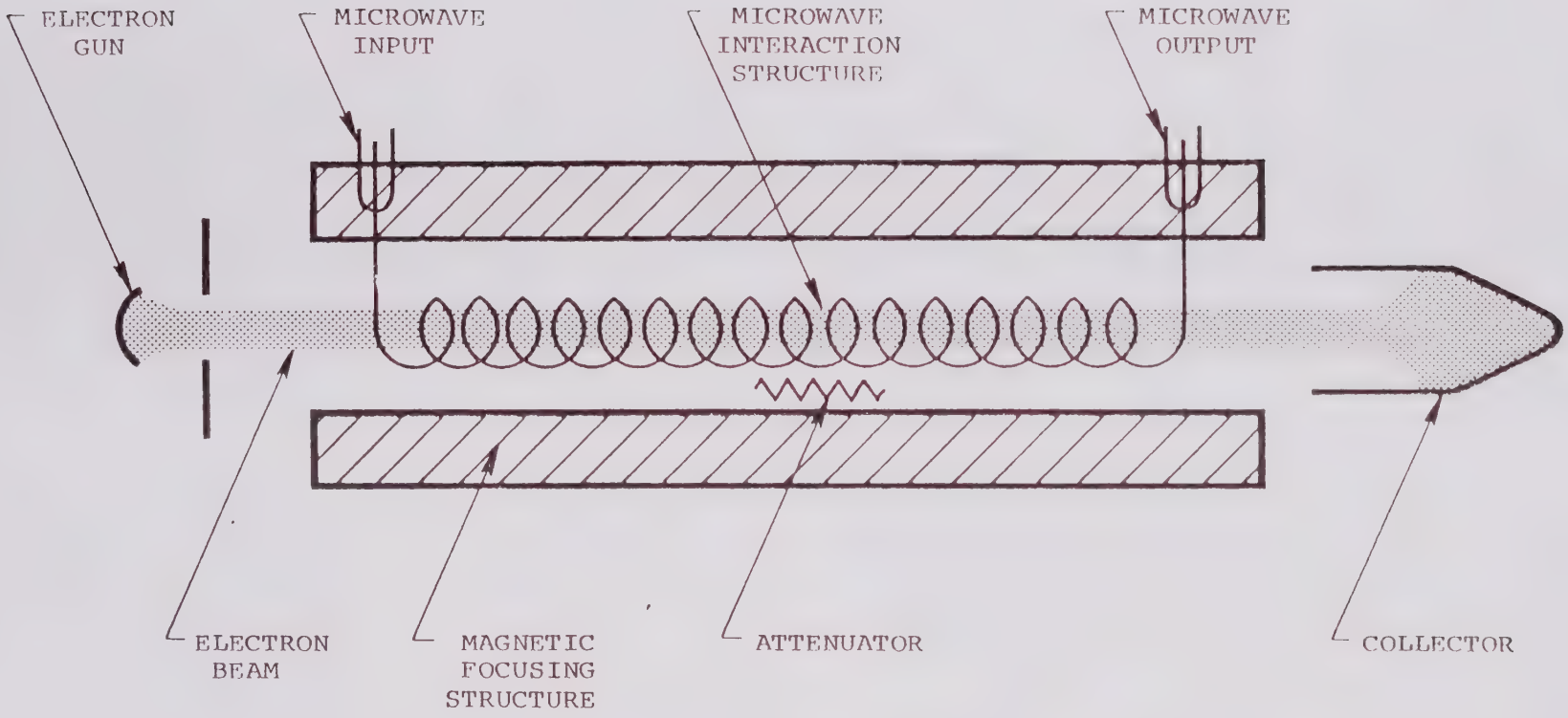


FIGURE 5-22 BASIC HELIX TWT

a) A circuit that will trip when reflected power exceeds a specified level.

b) An RF circulator and dissipative load that can withstand full reflection of the TWT output power.

5.3.3.1 High VSWR Trip. A coupler with a reverse power port is added on the output side of the RF section. The coupler is connected to a low pass filter which is connected to a fixed attenuator that is connected to a tunnel diode that converts the RF signal into a proportional DC output voltage. The output of the tunnel diode connects to one leg of a comparator (1A1U7B) on the logic board. The other leg of the comparator is connected to a resistor 1A1R6 that can be used to set the VSWR trip point. The specific components selected for a particular TWTA are a function of the power and frequency range of the specific TWTA. See the Special Features section for additional details.

5.3.3.2 Full Reflected Power Protection. A three port circulator is added to the output side of the RF Section. The reverse power port of the circulator is connected to a disapative load that will handle approximately twice the nominal rated power of the TWTA. Both the circulator and disapative load are frequency sensitive and are chosen for the particular TWT power and frequency range. See the Special Features section for further details.

5.3.4 Optional Elapsed Time Meter

An elapsed time meter is available for this amplifier series. An AC meter that is designed for either 50 or 60 Hz operation is available. Operating frequency is specified by the customer at the time of purchase. The elapsed time meter operates whenever the prime power CB1 is in the ON position.

SECTION 6

MAINTENANCE AND TROUBLESHOOTING

6.1 GENERAL

Instructions for maintenance of the Power Amplifier are presented for the functions of: Preventive Maintenance; Adjustments and Calibrations; and Corrective Maintenance, which includes troubleshooting and repair.

In the event that repair and/or modification to this amplifier is not performed by Varian or under Varian's direction, the warranty of the unit may be voided at Varian's sole discretion. See warranty information included at the rear of this manual.

If the system is not operating properly, and you cannot or do not intend to service it yourself, contact your nearest Varian field office for assistance.

****

WARNING

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LETHAL VOLTAGES UP TO 15 kV ARE PRESENT WHEN POWER IS APPLIED TO THE SYSTEM. BE EXTREMELY CAREFUL WHEN WORKING INSIDE THE UNIT. USE ONLY ONE HAND TO MAKE MEASUREMENTS OR ADJUSTMENTS. IF POSSIBLE TURN POWER OFF BEFORE MAKING ADJUSTMENTS. DO NOT ATTEMPT TO REPAIR OR TROUBLESHOOT THIS UNIT UNLESS YOU HAVE HAD EXPERIENCE IN SERVICING BOTH MICROWAVE AND HIGH VOLTAGE SYSTEMS.

****

NOTE

Do not disturb the lower mounting bolts of the Logic PWB A1. They do not have to be changed or loosened to remove the logic board.

The upper nuts of the logic board are removed, the board is slipped out and then the upper nuts are used to fasten the slotted end of the board to the chassis for maintenance access.

6.1.1 Access for Maintenance

Your TWTA is designed as a self-contained unit that can be bench or rack mounted. The unit is covered to provide proper thermal balance and cooling. The top and bottom covers must be removed for access for the maintenance procedures described in this section.

High voltage interlock switches are installed so that removal of either cover will automatically shut down the high voltage supply. These interlocks can be defeated by pulling out the pressure finger of the interlock switches.

****

WARNING

****

TREAT THE OPEN UNIT AS THOUGH HIGH VOLTAGE WAS ON WHENEVER THE COVERS ARE OFF THE UNIT.

****

****

WARNING

****

ANY TIME THE TOP COVER IS OFF, YOU ARE EXPOSED TO 120/230 VAC FROM THE PRIME POWER SOURCE IF THE TWTA IS CONNECTED TO THE PRIME POWER DISTRIBUTION SYSTEM.

****

CAUTION

Prior to applying power to the unit, verify that a suitable RF load, adequate to handle up to 400W CW without damage, and with a maximum VSWR of 1.5:1 across the power amplifier operating range, is provided at all times. Operation of the system without a suitable load can damage or destroy the TWT.

6.1.2 Test Equipment Required

Table 6-1 is a list of test equipment required in order to perform the maintenance routines described in subsequent sections. Equipment with equivalent accuracy or capacity may be substituted.

6.2 PREVENTIVE MAINTENANCE

This section presents information required to conduct preventive maintenance operations for the TWTA. Preventive maintenance comprises periodic visual inspection, routine cleaning, and those regularly scheduled service operations recommended to ensure system performance and accuracy levels.

TABLE 6-1

TEST EQUIPMENT REQUIRED

EQUIPMENT	MFG.	MODEL
General Item		
Sweep Oscillator Main Frame	H.P.	8620C
Frequency Counter	H.P.	5340A
Power Meter	H.P.	435A
Power Sensor	H.P.	8481H
Digital Voltmeter	Data Precision	245
Voltage Divider	Fluke	80F-15
Oscilloscope	Tektronix	475
High Voltage Monitor	Varian Associates	133522
Power Supply, 0-160 VDC, 200 mA	H.P.	6207B
Frequency Dependent Items		
Frequency Plug-In:		
.01 - 2.4 GHz	H.P.	8622A1B
2.0 - 8.4 GHz	H.P.	86240A1B
8.0 - 12.4 GHz	H.P.	86250D
12.4 - 18.0 GHz	H.P.	86260A
Couplers		
Waveguide:		
8.0 - 12.4 GHz	H.P.	X752D
12.4 - 18.0 GHz	H.P.	P752D
8.0 - 18.0 GHz	Technicraft	TDR 14011
4.8 - 11.0 GHz	Technicraft	TDR 22001
Coax:		
0.9 - 2.2 GHz	Narda	3042B Series
1.7 - 4.2 GHz	Narda	3043B Series
3.7 - 8.3 GHz	Narda	3044B Series
8.0 - 12.4 GHz	Narda	3045C Series
12.4 - 18.0 GHz	Narda	3096 Series
Adapters - W/G To Coax		
8.0 - 12.4 GHz	H.P.	X281A
12.4 - 18.0 GHz	Narda	609

TABLE 6-1 (Cont'd)

EQUIPMENT	MFG.	MODEL
Frequency Dependent Items		
Low Pass Filters		
1.5 GHz	Microlab	LA-15N
2.0 GHz	Microlab	LA-20N
3.0 GHz	Microlab	LA-30N
4.0 GHz	Microlab	LA-40N
6.0 GHz	Microlab	LA-60N
12.0 GHz	Microphase	LTP1200AB
Variable Attenuators		
1.0 - 8.0 GHz	Merrimac	AU26A
7.0 - 11.0 GHz	Merrimac	AU26H
12.0 - 18.0 GHz	ARRA	9804-20X
High Power Loads		
Waveguide:		
8.0 - 12.4 GHz	Narda	320B
12.4 - 18.0 GHz	Narda	319B
Coax:		
0.7 - 12.4 GHz	Narda	369B
2.0 - 12.4 GHz	Narda	368
Termination		
DC - 12.4 GHz	Narda	377N

As a major aid to maintenance, it is recommended that an operations log be maintained for the equipment. The log should be used to record all meter readings periodically and should note preventive and corrective maintenance conducted. Analysis of long term changes in operational conditions is of great value in predicting potential failures and in quickly analyzing cause of failures.

6.2.1 Visual Inspection

At periodic intervals, the TWTA should be inspected to permit early detection of wear or damage which, if properly corrected, will prevent equipment malfunction or failure. Inspections should include, but not be limited to, visual checks for wear, breaks, deterioration, fungus, excess moisture, mounting integrity, and other similar defects. In a normal environment, inspection should be made at 90-day intervals. If the equipment is subject to severe environmental conditions, such as dusty input ambient air, temperature extremes, or excessive shock or vibration, inspections should be performed on a weekly or monthly basis. Visual inspection items are listed in Table 6-2.

6.2.2 Routine Cleaning

The necessary materials and outline procedures for cleaning the TWTA are listed in Table 6-3.

****

WARNING

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TURN ALL POWER OFF BEFORE ATTEMPTING ANY CLEANING OPERATION. WHEN USING SOLVENTS, BE SURE TO PROVIDE ADEQUATE VENTILATION AND AVOID BREATHING THE FUMES. WHEN CLEANING WITH AIR, WEAR SAFETY GOGGLES AND USE CLEAN, DRY, COMPRESSED AIR NOT EXCEEDING 25 PSI.

****

TABLE 6-2

VISUAL INSPECTION ITEMS

Item	Potential Fault	Corrective Procedure
Connector Plugs	Damaged or improperly seated in mating connectors.	Replace connector plugs, properly seat replacement plug.
Electrical Wiring	Broken, burned or pinched.	Repair or replace defective wires.
Soldering Connection	Corroded, cracked or dirty.	Clean and resolder connections.
Dirt or Moisture Buildup	Short circuits, arcing, corrosion overheating.	Cleaning (See Table 6-3).

TABLE 6-3

ROUTINE CLEANING PROCEDURE

Item	Procedure
Chassis	Clean with lint-free cloth, small vacuum or low pressure compressed air.
Front Panel Controls and Meters	Use a dry, clean cloth, a soft-bristle brush, or a cloth moistened with warm soap and water or a similar cleaning compound. Use a Kimwipe tissue (or equivalent) and GTC glass cleaning compound (or equivalent) to clean the meter faces.
Wire Bundles and Wiring	Clean with a soft-bristle brush, small vacuum or compressed air.
Connector Jacks and Plugs	Remove dust and dirt with soft-bristle brush, small vacuum or low pressure air.
Circuit Boards	Clean with dry, soft-bristle brush, small vacuum or low-pressure compressed air.
Waveguide Assemblies, Clamps, Cables and Rubberized or Plastic Parts	Use low-pressure air or vacuum to remove excess dust and dirt. As an alternate, clean with soft bristle brush and lint-free cloth moistened with warm soap and water.

6.2.3 Lubrication

Chassis slides may occasionally require lubrication. To perform this maintenance, clean the slide mechanism with an approved solvent; lubricate with a small stiff-bristled brush and a light coat of Lubriplate No. 110 (or equivalent). Wipe off excess lubricant with a clean lint-free cloth. No other lubrication is required for the TWTA.

6.2.4 Paint Touch-Up

Most finish repairs consist of retouching minor marred or scratched surfaces. A camel's hair brush lightly dipped in a suitable enamel will accomplish the touchup desired. Deep scratches, chips, and gouges should first be smoothed or removed by a light sanding with fine (No. 00 or 000) sandpaper and then the surface painted as required to restore the finish. Varian's standard paint color is light grey #26440 per Fed. Std. 595.

6.3 ADJUSTMENTS AND CALIBRATION

6.3.1 General

Adjustment and calibration of the Power Amplifier is required when either TWT or a major assembly is replaced or after repairs have been made. No adjustment procedure should be attempted until the Theory of Operation Section of this manual is read and the function of the circuits and circuit adjustments are fully understood. A Test Data Sheet (Test Performance Sheet) is supplied with each TWTA. This sheet contains information on the proper voltages, currents and other parameters that apply to the specific TWTA. These values are to be used when adjusting or calibrating the TWTA.

****

WARNING

****

LETHAL VOLTAGES UP TO 15 kV ARE PRESENT IN THE POWER AMPLIFIER WHEN IT IS OPERATING. USE EXTREME CAUTION WHEN WORKING INSIDE THE UNIT. AS AN ADDED PRECAUTION, IT IS RECOMMENDED THAT ANOTHER PERSON BE PRESENT TO GIVE AID IN CASE OF ACCIDENT. DO NOT ATTEMPT TO SERVICE THE TWTA UNLESS YOU ARE FAMILIAR WITH SAFETY PROCEDURES FOR RF AND HIGH VOLTAGE SERVICING OPERATIONS.

****

Figure 6-1 depicts the TWT and power supply interconnections. The major supplies are the filament, helix and the collector supply. See Section 5.2.5 for the Theory of Operation of these supplies. All voltages referred to in discussion are approximate voltages. Refer to your TWTA Test Data Package for the exact operating voltages.

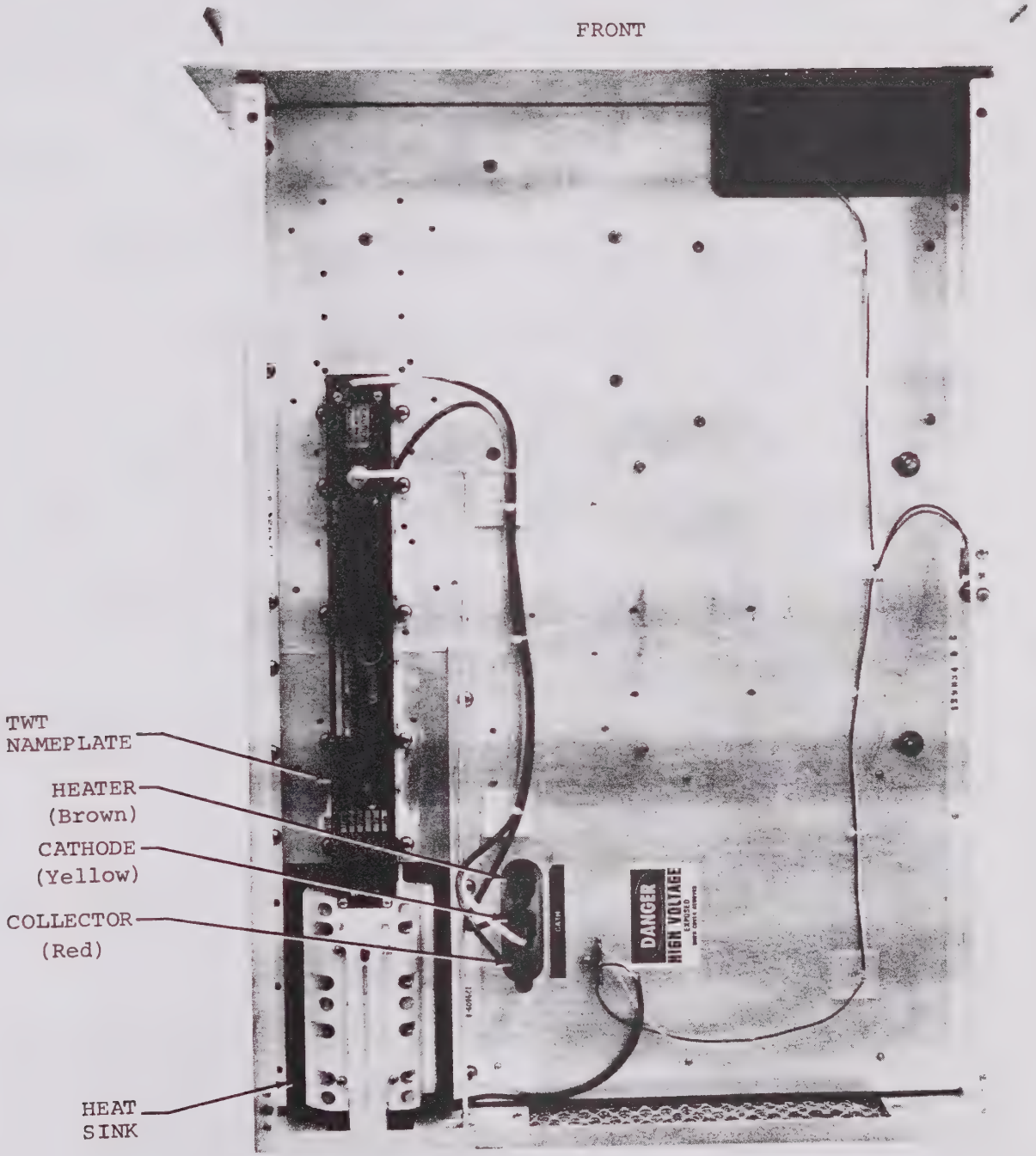
6.3.2 Adjustment Locations

Table 6-4 identifies and defines the functions of the Adjustment Points of the TWTA, and Figure 6-2 indicates the location of the adjustment points.

6.3.3 Parts Replacement

6.3.3.1 TWT Replacement. The TWT is non-repairable and must be replaced if faulty. The following procedure should be followed for TWT replacement:

a. Remove all power from the power amplifier and wait 30 seconds to allow all voltages to discharge.



BOTTOM VIEW TWTA

FIGURE 6-1 TWTA/POWER SUPPLY INTERCONNECTORS

TABLE 6-4

SUMMARY OF ADJUSTMENT PROCEDURES

Function	Location of Control	Procedure * Reference
Set No-load Regulator	A2R30 on A2 PWB	Sec. 6.3.4.1 step a
Set TWT Helix Voltage	A3R53 on A3 PWB	Sec. 6.3.4.7 steps a thru i.
Set Switch Regulator Peak Current Limit Point	A3R5 on A3 PWB	Sec. 6.3.4.10
Adjust Switch Regulator (-200 VDC) Overvoltage Trip Point	A2R38 on A2 PWB	Sec. 6.3.4.11
Adjust for minimum 60/120 Hz Ripple	A3R29 on A3 PWB	Sec. 6.3.4.9
Set Filament (Heater) Voltage	A4R2 on A4 PWB	Sec. 6.3.4.7 steps a thru e.
Set Converter Over-current Trip Point	A4R18 on A4 PWB	Sec. 6.3.4.12
Adjust Helix Trip Point	A1R3 on A1 PWB	Sec. 6.3.4.13
Adjust VSWR Trip Point	A1R6 on A1 PWB	Sec. 6.3.4.14

* Also refer to Test Performance Sheet that accompanies each TWTA.

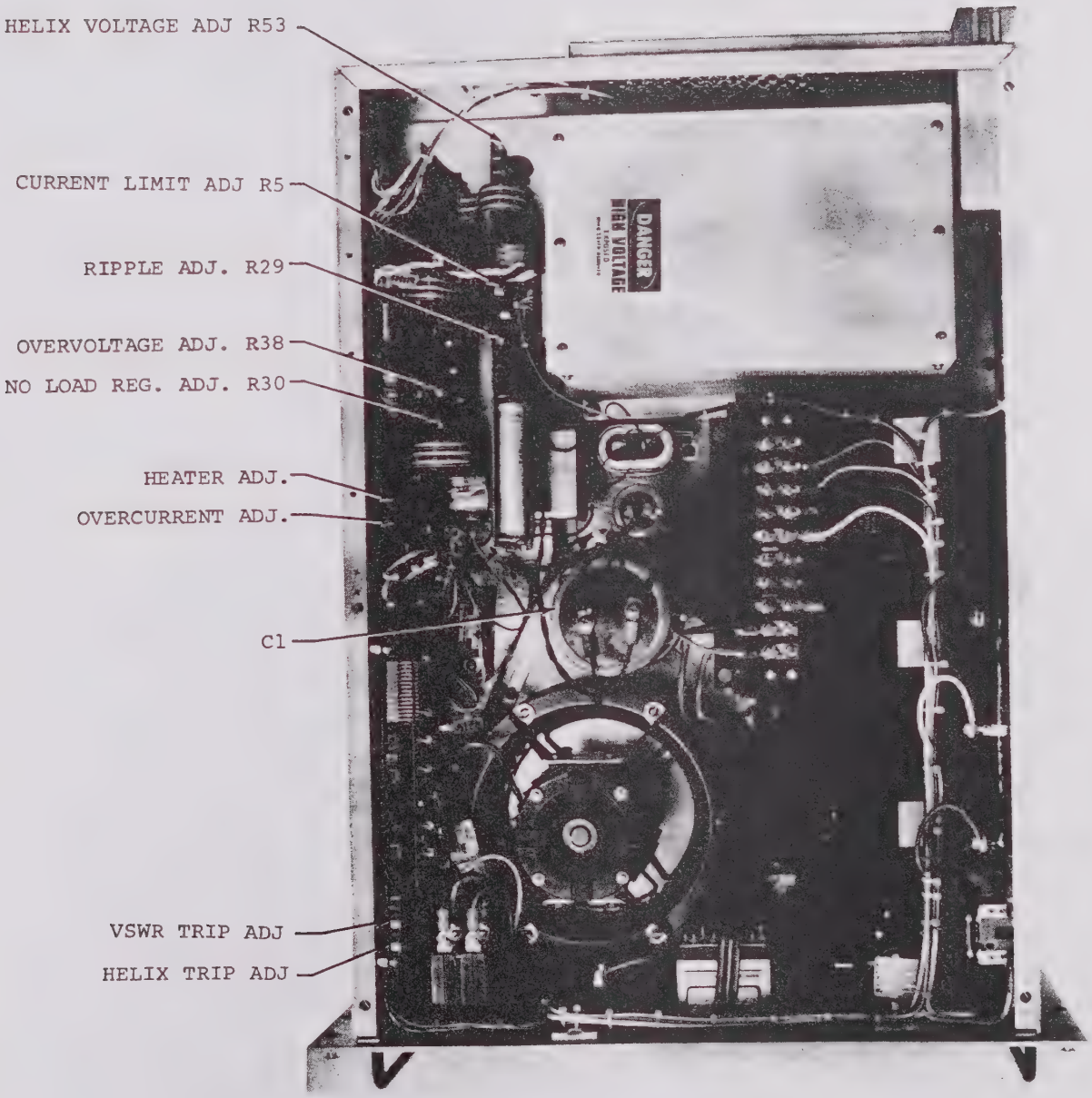


FIGURE 6-2 TWTA POWER SUPPLY ADJUSTMENTS

b. Loosen the fittings on the input and output of the TWT.

c. Disconnect the TWT high voltage connectors from the high voltage module J1, J2, J3.

d. Disconnect the two wires that go to TB2 mounted next to the heatsink.

e. Unscrew the TWT from the TWTA chassis and lift out the TWT.

f. Install new high voltage male connectors to the TWT leads as shown in Figure 6-3. Proceed as follows:

   1) Install pin on lead and crimp in place.
   2) Coat the lead insulation with a small amount of RTV 3145 Sealant keeping the barrel of the pin free of sealant.
   3) Insert the pin into the HV connector. Verify that it locks into place.
   4) The sealant will set up in 3-4 hours. Try not to disturb for 24 hours to allow for full cure.

Clean off all of the thermal compound from the heatsink. Apply a very thin coat of new thermal compound (Wakefield No. 120 or equivalent) to the heatsink and the replacement TWT. Reinstall the replacement TWT following the reversed procedure above. The wires to J1, J2, J3 are color coded. See label on chassis adjacent to these connectors and match wire colors to label. Be sure that all screws are tight for the heatsink and the TWT and that there is a thin coating of thermal compound applied.

6.3.3.2 Module and Component Replacement. The printed circuit boards, modules, RF components, and miscellaneous can be completely removed or replaced using simple assembly techniques. Several cautions, however, should be noted:

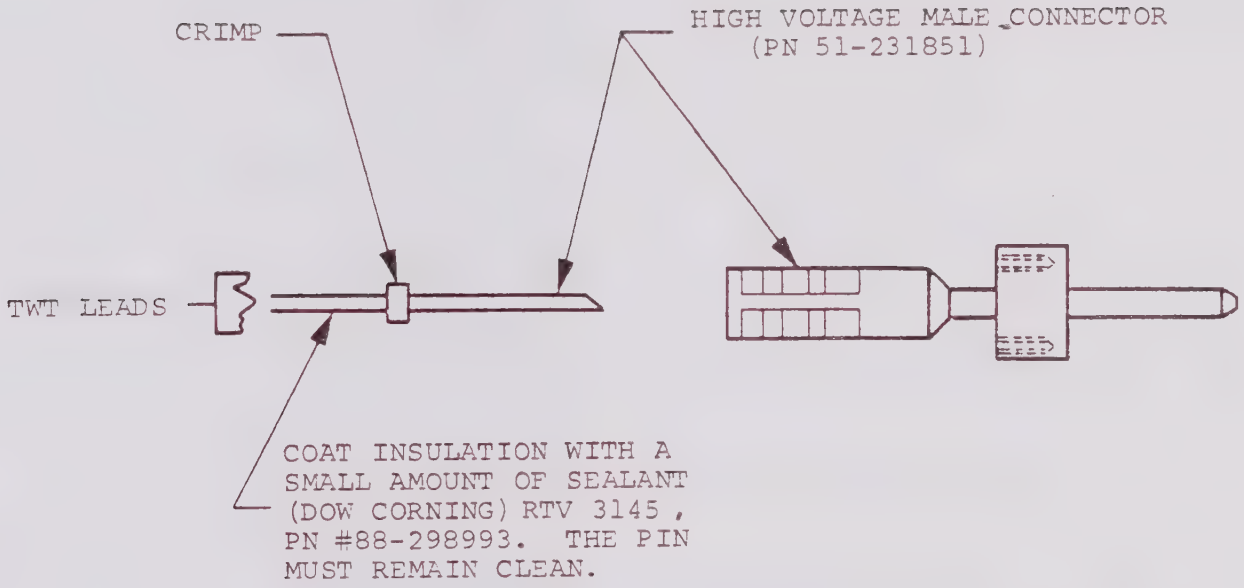


FIGURE 6-3 INSTALLATION AND POTTING OF HV CONNECTORS

a. Upon reassembly, all screws should be snug.
b. All components with thermal compound must be cleaned and a thin coating of new thermal compound reapplied. (Use Wakefield No. 120 or equivalent).
c. All solder connections must be mechanically and electrically sound.
d. All connections must be completely installed and properly seated.

6.3.4 Adjustment After Major TWTA Repairs

Performing the adjustments necessary to make the power supply operational after repair involves disconnecting the various sections of the circuit from each other; making the adjusts; and reconnecting the circuits in a logical sequence after the adjustments have been made.

The basic operations that are discussed in detail in the following sections are as follows:

a. Check 300 Vdc and 38 Vdc voltages.
b. With the input to the switch regulator disconnected, the ±4 Vdc, -30 Vdc, 29 Vac and +12 Vdc voltages are checked.
c. The 200 V UV protection, switch regulator and converter drive signals are checked with the input to the switch regulator disconnected.
d. With the switch regulator connected and the bridge converter disconnected, the switch regulator output voltage, current limit point and 200V OV protection are set and checked.
e. The bridge converter is connected, primary waveshape checked.
f. With the TWT disconnected, the high voltage is turned on and helix to cathode voltage is checked and pre-adjusted.

g. The TWT is connected. The TWT heater voltage is checked with the high voltage off.

h. The high voltage is turned on. Helix voltage is set to the TWT specification.

i. Helix to cathode ripple is adjusted to minimum.

Specific procedures are outlined below.

NOTE

Remove power and disconnect TWT at J1, J2 and J3 on HV Module before proceeding.

6.3.4.1 300VDC and 38VDC Measurement Checks (See Figure 6-2, Dwg. 113979)

a. Connect VOM across C1, Figure 6-2, positive to red lead (common) negative to black lead (-300V). If the switch regulator card is disconnected by removing A3P2, then connect a jumper from C1(+) to C2(+).

b. Turn on CB-1. Set OPERATE/OFF/RESET switch to OFF/RESET. Voltage will be 300 VDC ± 10 VDC. Omit steps b.1, b.2, and b.3 if voltage is greater than 50VDC. You can check operation of bleeder at this point by turning off CB-1. Voltage should discharge in less than 30 seconds.

b.1 If, when CB1 is turned on, the 300 DC comes and reaches approximately 225 VDC and then drops to zero, there is a problem resulting in an SCR shutdown.

b.2 Thrn off CB1. Wait 30 seconds. Remove from C1 (negative) the black lead that goes to the switch regulator (A3) assembly, Figure 6-2.

b.3 Turn on CB1 and measure 300 VDC ± 10 VDC across C101.

c. If the 300 VDC needs adjustment, adjust A2R30 to read 300 ± 10 VDC on VOM.
d. Turn off CB1. Wait 30 seconds. Connect VOM across C2, Figure 6-2.
e. Turn on CB1 and read 45 VDC ± 5 VDC.
f. Turn off CB1. Wait 30 seconds, disconnect VOM.
g. Remove VOM.

NOTE

Some of the early units do not include all the test points (TP) referenced in the following procedures. Where appropriate, an equivalent connection point is noted in parenthesis next to the TP of interest.

6.3.4.2 30 VAC, -30 VDC, +12 VDC and ±15 VDC Checks (See Figure 6-4, Dwg. 113483)

a. Turn off CB1 and wait at least 30 seconds.
b. Disconnect input to switch regulator at C1 (black lead to C1 negative).
c. Refer to assembly drawing 113483.
d. Locate J3 and connect VOM/DVM to the following pins: Turn on CB1 and read:
    1. TP-7 (or A2J3-13) to chassis. Read -30 ± 1.5 VDC.
    2. TP4(+) to TP5(-) or A2J3-8(+) to A2J3-6(-). Read +5 to +10 VDC.
    3. TP5(+) to TP6(-) or A2J3-7(-) to A2J3-6(+). Read -5 to -10 VDC.
e. Locate A2J4 and connect VOM/DVM from TP-3(+) (or A2J4-7(+) to chassis. Read +12 VDC ± 1 VDC.
f. Locate J4 and connect scope from TP-1 (or J4-3) to chassis. Read 60V p-p square wave at 10 kHz ± 1.5 kHz.

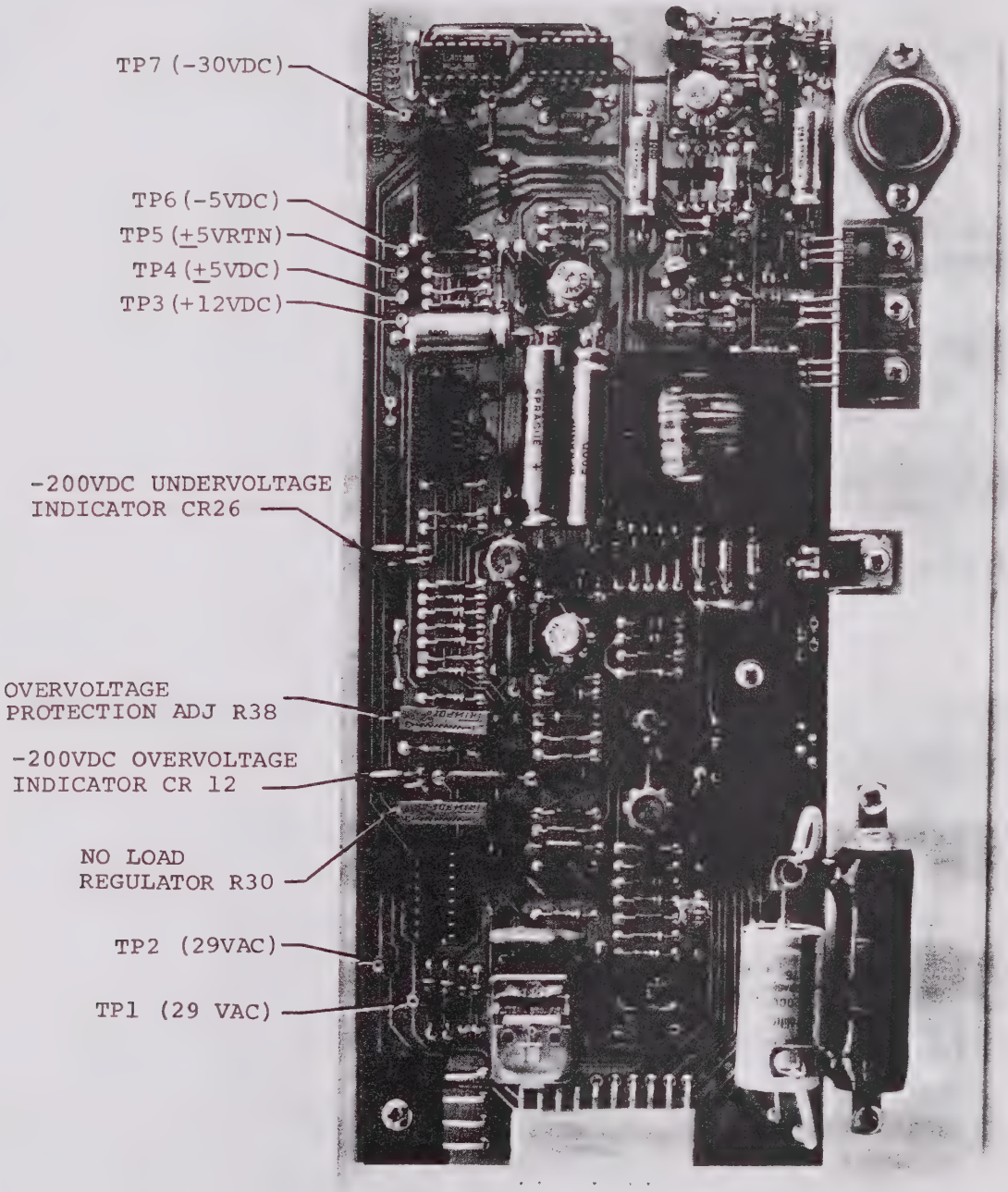


FIGURE 6-4 OSC/BIAS PWB A2 ADJUSTMENTS AND TEST CONNECTIONS

6.3.4.3 Check the 200 Volt Undervoltage Circuit, Switch Regulator and Converter Drive Signals (See Figure 6-4, Dwg. 113483)

a. Turn off CB1 and wait at least 30 seconds.
b. Disconnect black lead from the switch regulator to C1 (negative).
c. Turn on CB1, wait for STDBY light. Turn on the HV control switch. The BEAM ON light will momentarily light. The FAULT light will turn on and LED CR26 will turn on. This completes the functional check of the 200 volt undervoltage current.
d. Turn off CB1, wait at least 30 seconds and then connect a jumper across C19.
e. Turn off HV control and connect DVM/VOM from J3-1 (neg) to chassis.
f. Turn on CB1. Read $\leq$ 1 VDC.
g. Turn on HV control and read -30 VDC ± 1 VDC.
h. Turn off CB1 wait at least 30 seconds. Remove jumper from C19.
i. Reconnect input to switch regulator at C1 (negative) black wire.

6.3.4.4 Check The -200 VDC Output (See Figures 6-4, 6-5 and 6-6)

a. Turn off CB1.
b. Reconnect switch regulator input to C1 (negative) if previously disconnected.
c. Refer to Figure 6-6. Disconnect A4J1 from HV converter PWB A4. Connect DVM/VOM from A3E7 (TP-8) to chassis. Connect a jumper from A3E7 (TP-8) to A3E10. (The switch regulator will not operate without a load unless a jumper or a 56K resistor is placed across A3E7 (TP-8) and A3E10).

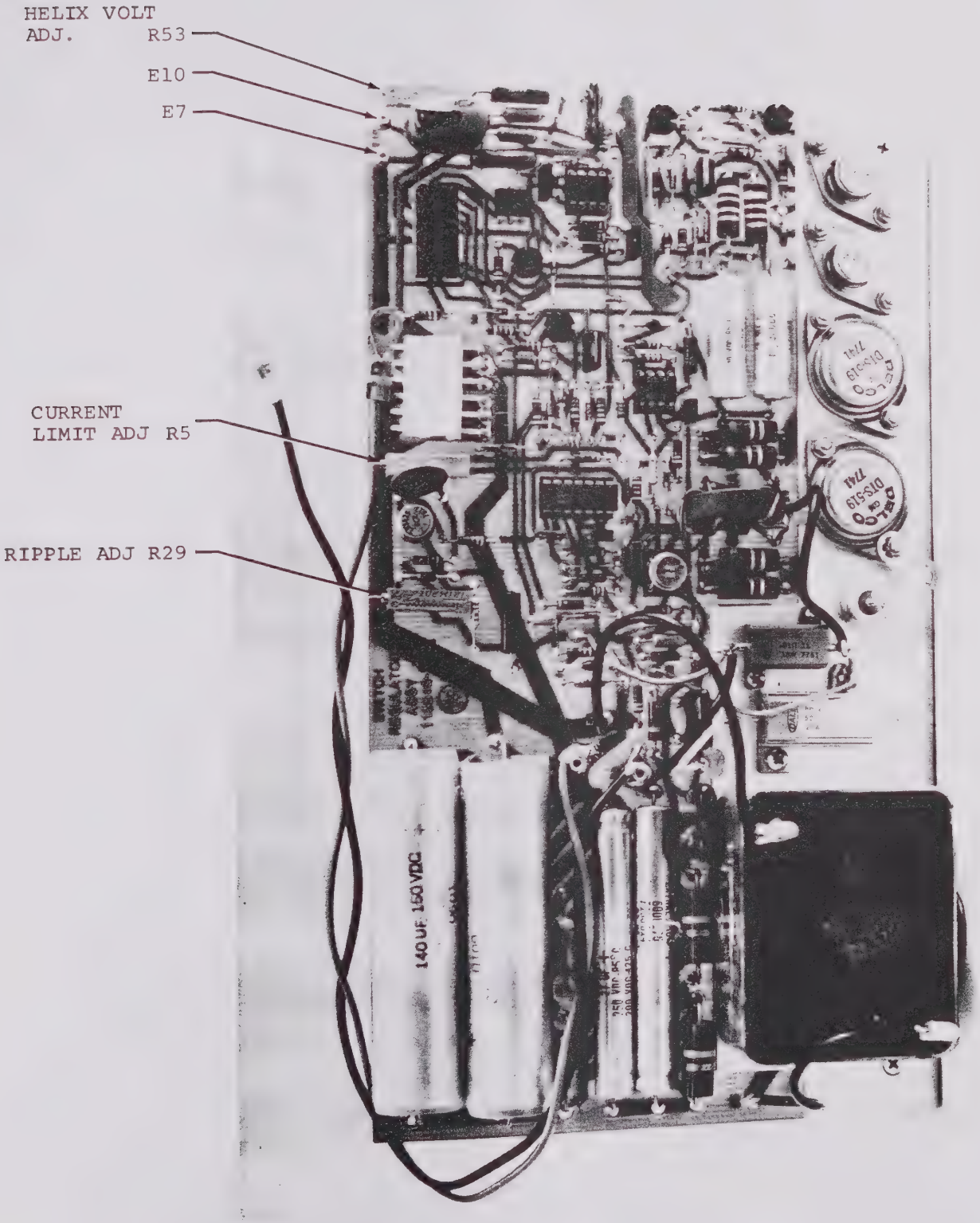


FIGURE 6-5 SWITCH REGULATOR PWB A3 ADJUSTMENTS AND TEST CONNECTIONS

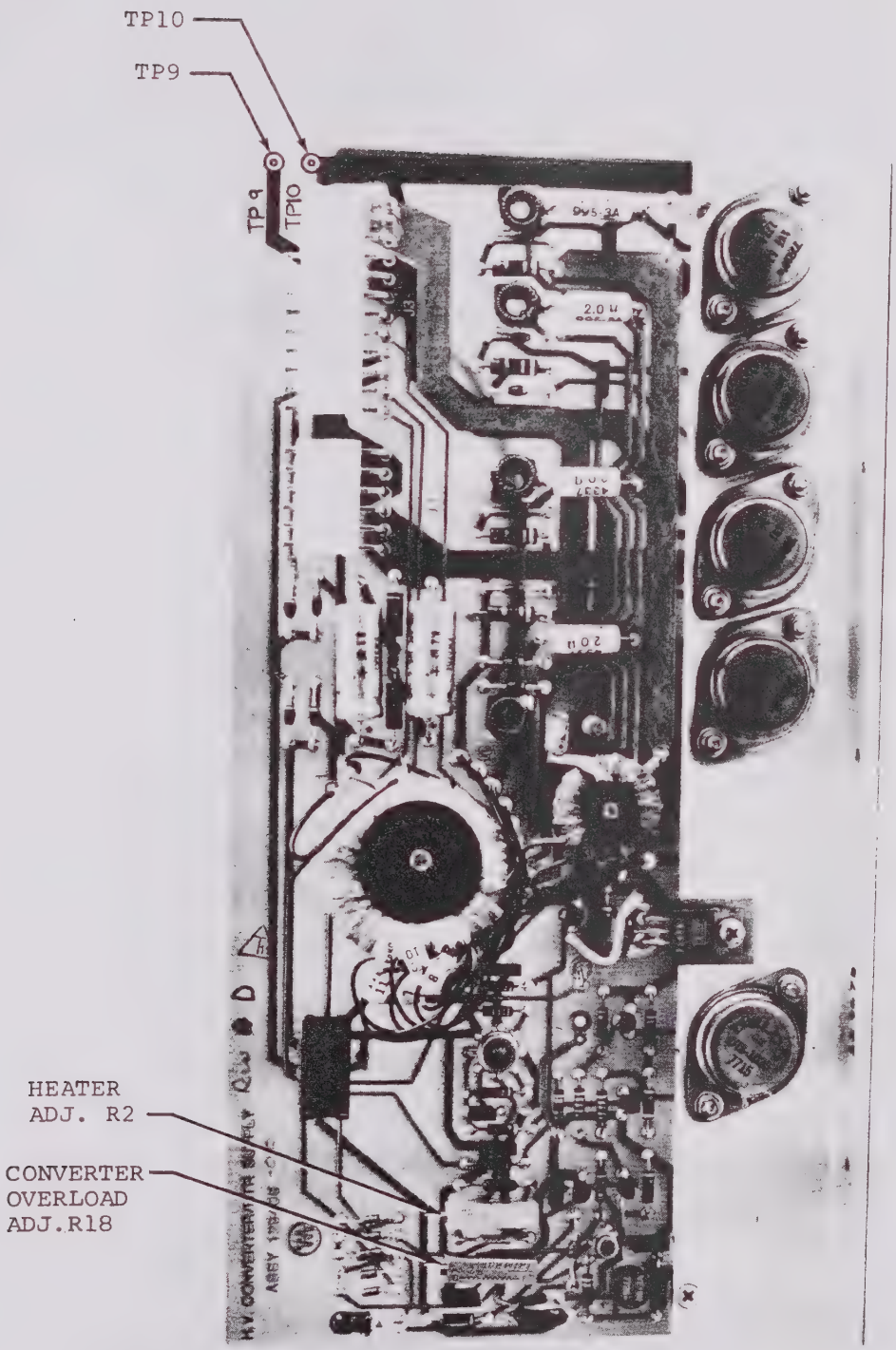


FIGURE 6-6 HV CONVERTER PWB A4 ADJUSTMENTS AND TEST CONNECTIONS

NOTE

The test data package that was shipped with the TWTA includes information on jumper connections and power supply voltages. These voltage references are used in the setup of the P.S. and for TWT mating purposes.

d. Turn on CB1 and wait for standby light. Turn on high voltage control and read and record the switch regulator voltage for this unit at no-load. Compare this value to the no-load voltage given in the Test Data Package.

   If the DVM/VOM reads voltage momentarily and then falls to zero and the logic goes to the standby position, locate LEDs CR12 and CR26.

NOTE

CR12 and CR26 are fault indicators. CR26 is the undervoltage protection circuit and will light and turn off drive signals if the switch regulator output is below $\approx$ 120 VDC. CR12 is the overvoltage protection circuit and will light and turn off drive signals if the output is greater than $\approx$ 240 VDC.

1. If CR26 is lit, adjust A3R53 CW 3 full turns. Turn off HV control momentarily to reset CR26. Now turn on HV switch and read $>$ 120 VDC.
2. If CR12 is lit, adjust A3R53 CCW 3 full turns. Turn off HV switch momentarily to reset CR12. Turn on HV control and read $<$ 240 VDC.

When you have obtained normal turn on, return to step d.

e. If the voltages compared in step d. are not equal within ±3V, set switch regulator NO LOAD voltage to value recorded in Test Data Package using A3R53.

f. Turn off CB1. Wait 30 seconds. Remove the jumper (step c) from A3E7 and A3E10.

g. Reconnect A4J1 to A4P1.

6.3.4.5 Check HV Input Converter. (See Figures 6-2, 6-3, Dwg. 129405). If trouble is suspected in HV converter, refer to Paragraph 6.4.2.

a. Turn off CB1. Wait at least 30 seconds and connect input of switch regulator A4 (black lead) to C1 (negative), Figure 6-2, if previously disconnected.

b. Connect J1 if previously disconnected.

c. Disconnect A4J3 from HV converter (A4), Figure 6-6.

d. Connect Jumper from E7 (TP8) to E10 on Switch Regulator A3.

e. Connect a jumper from A4J3-1 to the chassis and from A4J3-6 to chassis.

f. Connect scope to A4 TP-9 (or A4J3-8) to chassis (50 V/cm vertical; 20 μsec/cm sweep).

g. Turn on CB1. Wait for STANDBY light on the front panel indicator.

h. Turn on HV control. Read 10 kHz ± 1.5 kHz square wave on scope. Peak voltage will be equal to switch regulator output voltage.

i. Turn off HV control. Reconnect scope from TP-10 (or A4J3-11) to chassis. Turn on HV control. Read same 10 kHz square wave on scope.

j. Turn off CB1. Wait 30 seconds.

k. Remove jumpers from A3E7-E10 on switch regulator, A4J3-1 to chassis, and A4J3-6 to chassis.

l. Reconnect A4J3 to A4P3.

6.3.4.6 High Voltage Module A5 No-Load Check (See Figure 6-7, 6-8 and Dwg. 113919)

a. Turn off CB1. Wait 30 seconds.
b. Remove jumper from A3E7 (TP-8) to A3E10 if installed previously.
c. Remove TWT leads P1, P2 and P3 from A5J1, J2 and J3 if not previously removed.

NOTE

The procedures in this manual that deal with high voltage measurements are based on the use of a High Voltage Monitor, Varian Part No. 133522. The High Voltage Monitor incorporates a high voltage divider, a meter and switch that allows helix and connector voltages to be measured without the use of additional equipment.

d. Install the High Voltage Monitor by inserting plugs P1, P2, P3 on the High Voltage Monitor into the HV Module A5. (Figure 6-9) Observe the color codes on the jacks and plugs as follows:

Red - Collector
Yellow - Cathode
Brown - Heater

e. Install terminating plug on output connector of H V Monitor.
f. Connect the ground lead from the HV Monitor to the chassis.

****

WARNING

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THE BODY OF THE HIGH VOLTAGE MONITOR WILL BE FLOATING UNLESS THE GROUND LEAD IS PROPERLY ATTACHED. IN ADDITION, ANY VOLTAGE READING MADE WITHOUT USE OF THE GROUND WILL BE SUSPECT.

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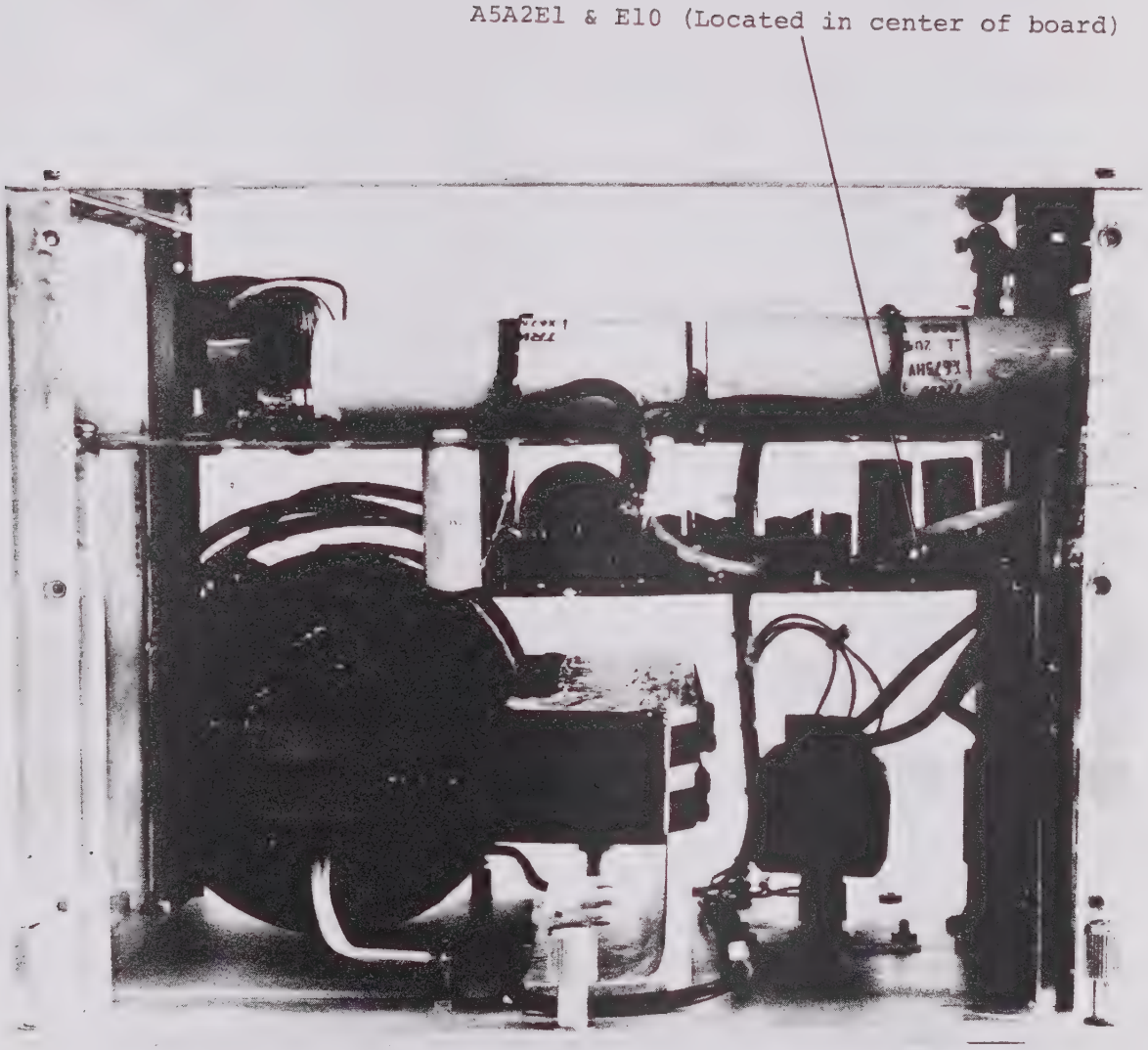


NOTE: SEE ASSEMBLY DWG 113902 FOR EXACT LOCATION OF E1 &E10

FIGURE 6-8 HIGH VOLTAGE MODULE PWB #2 (A5A2)

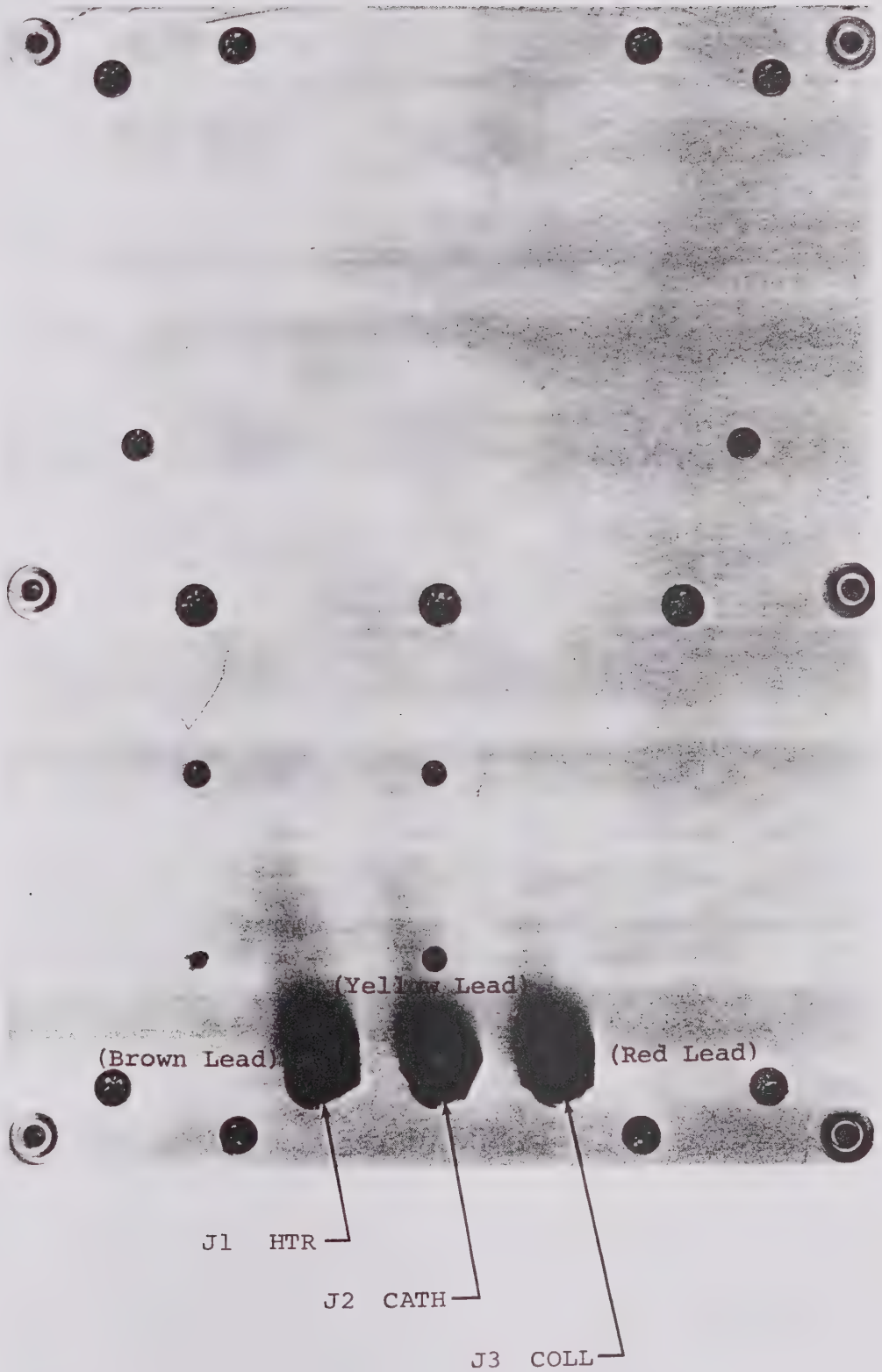


FIGURE 6-9 HV MODULE A5 CONNECTIONS

g. Set OPERATE/OFF/RESET switch to OFF/RESET. Turn CB1 on. Select HEATER position on HV Monitor. Read the unloaded heater voltage and record the value. The unloaded heater voltage reading should be approximately 10 volts D.C. (Do not adjust at this time.)

h. Select the HELIX position on the HV Monitor. Set to OPERATE. Read the meter and record the values. This should match the value given in the test data package. If not, adjust A3R53 to give the correct value for your TWT.

i. Switch to the COLLECTOR position on the HV Monitor. Read and record the value. All that is required is to get an indication that collector voltage is present.

NOTE

The No-Load collector voltage reading does not represent the loaded collector voltage reading and is used only to verify that collector voltage is being generated. The actual collector voltage reading can only be made using the TWT as a load or by using a "dummy resistive load" capable of handling the same rated power as the TWT in use in the system.

j. Turn H.V. control to OFF/RESET. Turn off CB1.

NOTE

Leave the H.V. Monitor installed if you plan to make final adjustments and refer to paragraph 6.3.4.7. Otherwise, remove the monitor, secure the equipment and reinstall TWT leads P1, P2, P3.

6.3.4.7 Final Settings of Heater Voltage, Cathode To Helix Voltage and Collector Voltage. Proceed as follows: (Ref. Fig. 6-5)

NOTE

This procedure requires use of the High Voltage Monitor (Varian Part No.133522) (Section 6.3.4.6).

If the TWT or HV module is replaced, refer to Section 6.3.4.8 for selection of proper transformer taps.

a. Turn off CB1.
b. Turn HV control to OFF/RESET. Wait 30 seconds.
c. Remove jumper from A3E7 to A3E10 of Switch Regulator A3 (Figure 6-5) if previously installed.

****

WARNING

****

THE MEASUREMENT OF THE CATHODE TO HELIX VOLTAGE EXPOSES THE OPERATOR TO POTENTIAL VOLTAGES AS HIGH AS 15 kV. EXTREME CAUTION MUST BE EXERCISED IN MEASURING THE HIGH VOLTAGE SECTIONS OF THIS POWER SUPPLY.

****

d. Connect leads P1, P2 and P3 of TWT to J1, J2 and J3 of the HV Monitor. P1, P2 and P3 of the HV Monitor should be connected to J1, J2 and J3 of HV Module A5.
e. Connect the ground lead from the High Voltage Monitor to the chassis.

****

WARNING

****

THE BODY OF THE HIGH VOLTAGE MONITOR WILL BE FLOATING UNLESS THE GROUND LEAD IS PROPERLY ATTACHED. IN ADDITION, ANY VOLTAGE READING MADE WITHOUT USE OF THE GROUND WILL BE SUSPECT.

****

f. Turn on CB1. The voltmeter will read less than 6.3 VDC. As the timing cycle is completed, the voltage will increase to 6.35 VDC ± .1 VDC. If, after the timing cycle is complete and the logic is in STANDBY, the HV Monitor reads other than 6.35 VDC ± .1 VDC, locate A4R2, Figure 6-6,and adjust A4R2, to read 6.35 VDC ± .1 VDC.

g. Select HELIX position on H.V. Monitor.

h. Note helix-to-cathode and collector voltages in Test Data Package. Record this voltage for use later in procedure. If Test Data Package not available, use the name plate values on the TWT.

i. Set HV control on to OPERATE. Voltage on HV Monitor should be within ±0.2% of voltage recorded at step h. of this procedure.

j. If voltage needs adjustment, refer to Figure 6-5 and adjust A3R53 on Switch Regulator (A3) to the voltage indicated in step h.

k. Select COLLECTOR position on HV Monitor and record this voltage. Compare with the recorded collector voltage on the test data package.

NOTE

The collector voltage is a tap selected percentage (see 6.3.4.8) of the cathode to helix voltage.

The collector voltage read by the H.V. divider should be within the limits for the particular TWT type in use as outlined by Table 6-5. For example, TWT type VTU-6252F1 will operate properly with any collector voltage from 2.8 KVDC to 3.3 KVDC. If the measured voltage falls outside the ranges in Table 6-5, refer to 6.3.4.8 for HV transformer tap selections.

l. Turn off CB1. Set HV control to OFF/RESET. Wait 30 seconds.
m. Remove HV Monitor.
n. Reinstall P1, P2, P3 in A5J1, J2, J3.
o. This completes this procedure.

6.3.4.8 H.V. Transformer Tap Adjustments and Voltage Divider String Resistor Selection. If a replacement TWT or H.V. module is to be used in the TWTA, the following procedure is to be used in readjusting the helix-cathode and collector to cathode potentials.

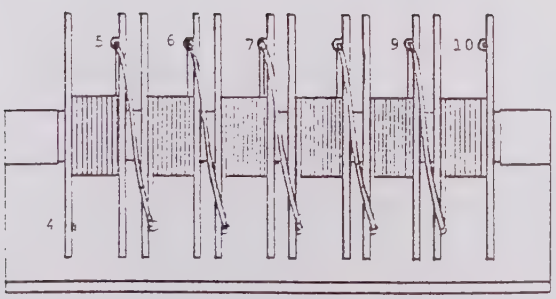
a. Compare the new voltage requirements with the previous TWT voltages. If they are comparable (within a few percent) tap adjustments and jumper changes are probably not required. In this case, proceed to Section 6.3.4.7. If the correct voltages cannot be obtained in section 6.3.4.7, perform the succeeding steps.
b. Remove all power from the TWTA.
c. Disconnect all connections to the HV Module A5 and remove this assembly from the TWTA by unscrewing six captive fasteners.

TABLE 6-3

HIGH VOLTAGE CONNECTION FOR VARIOUS TWTs

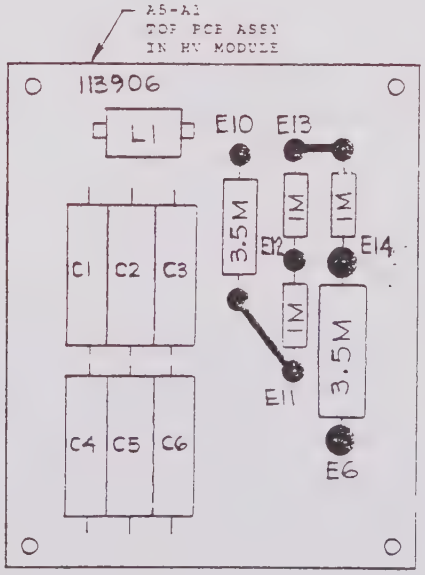
TWT	A5-T2 SECONDARY CONNECTIONS (SEE DETAIL A) VIOLET LEAD	GRAY LEAD	BLUE LEAD	A5-A1 JUMPERS INSTALLED (2) (SEE DETAIL B)	TYPICAL OPERATING CONDITIONS: HELIX TRIP POINT SETTING mA	RANGE OF VALUE A3-R53 SETTING	HELIX VOLTAGE KV	HELIX CURRENT mA	COLLECTOR VOLTAGE KV	COLLECTOR CURRENT mA	SWITCH REGULATOR TYPICAL OUTPUT -VDC
VTL-6295F1 VTL-6290F1	4 (1)	10	10	NONE	25	LOW	8.4	20	4.2	220	165
						HIGH	9.0	20	4.51	220	174
VTH-6272F1	4	10	10	NONE	25	LOW	8.7	20	4.34	350	174
						HIGH	9.3	20	4.65	350	185
VTC-6264F1 VTC-6262F1	4	10	9	NONE	25	LOW	8.2	20	4.47	300	177
						HIGH	8.8	20	4.8	300	189
VTC-6270F1 VTC-6260F1	4	9	7	E10 TO E12	25	LOW	5.0	20	3.59	240	168
					15	HIGH	5.6	20	4.0	240	188
VTS-6252F1	4	8	5	E10 TO E13	60	LOW	3.5	60	2.89	420	179
						HIGH	4.1	60	3.3	420	203
VTL-6242F1	4	9	4	E10 TO E14 E10 TO E13	60	LOW	3.3	60	3.25	450	168
						HIGH	3.8	60	3.76	450	188
VTL-6240F1	4	8	4	E10 TO E14	45	LOW	2.8	40	2.8	350	168
						HIGH	3.31	40	3.3	350	203
VTC-6232F1	4	8	6	E10 TO E13 E10 TO E12	45	LOW	4.2	40	2.85	450	176
						HIGH	4.6	40	3.1	450	199
VTS-6250F1	4	7	5	E10 TO E11 AND E6 TO E14 E10 TO E13	45	LOW	2.7	40	2.06	350	168
						HIGH	3.3	40	2.52	350	203
VTC-6260F1 VTH-6270F1 VTX-6280F1	4	9	6	E10 TO E13	15 25 25	LOW	5.0	20	3.3	240	170
						HIGH	5.6	20	4.1	240	200

NOTES: (1) TRANSFORMER TERMINALS
(2) VALUE OF RESISTANCE IN STRING = 10M - SHORTED PORTION



A5-T2
HV TRANSFORMER

DETAIL A



DETAIL B

d. Remove top and side covers from HV Module.

e. Refer to Table 6-5. Select the TWT type. Find the corresponding connections to transformer A5-T2 and the jumper connections on A5-A1.

NOTE

The wires are color coded that connect to the H.V. transformer. The colors are violet, gray and blue.

f. Check the top PCB of the HV Module (Figure 6-7) to make sure the jumpers installed on the "E" terminals agree with the callouts in Table 6-5. If not, remove all old jumpers and install new jumpers between the correct "E" terminals. (The "E" number represents the terminals on the HV Mod. PCB that must be jumpered in selecting the voltage divider resistance to be used).

g. Check the connections to A5-T2 to make sure that the violet, grey and blue wires are connected as indicated in Table 6-5. If not, disconnect these and reconnect to the correct taps.

h. After the transformer taps and the resistors for the voltage divider string have been selected, refer to Paragraph 6.3.4.6 to set the helix-to-cathode voltage and 6.3.4.7 to check the collector-to-cathode voltage.

NOTE

TWT Types VTC-6242F1, VTC-6232F1, and VTS-6250F1 require two separate combinations of the divider string to allow adequate adjustment range of the helix-to-cathode voltage as indicated on the Table 6-5. Select the combination that gives the desired helix-cathode voltage for your TWT.

6.3.4.9 Setting of Ripple Adjustment (See Figure 6-5)

a. Turn off CB1. Wait 30 seconds.
b. Connect scope from A3E7(TP-8) of Switch Regulator A3 to chassis (Figure 6-5).
c. Turn on CB1. Wait for STANDBY light.
d. Turn on HV control and note the 100-120 Hz ripple voltage on switch regulator output on oscilloscope.
e. Adjust A3R29 on switch regulator A3 for minimum AC ripple component as viewed on oscilloscope.
f. Turn off high voltage switch.
g. Turn off CB1. Wait 30 seconds.
h. Disconnect oscilloscope.

6.3.4.10 Adjustment of Switch Regulator Peak Current. A3R5 is preset at the factory and normally needs no adjustment. If adjustment is required, use the following procedure:

a. Turn off CB1. Set HV control to OFF/RESET. Wait 30 seconds.
b. Adjust A3R5 fully CCW.
c. Connect VOM and oscilloscope from A3-E7 to chassis.
d. Turn on CB1 and wait for STANDBY light. Set HV control to OPERATE. VOM will read zero volts and the front panel indicator will indicate BEAM ON for $<$ 1 sec. and return to STANDBY. A2-CR26 on Osc/Bias PWB will be on. This is normal.
e. Set HV control to OFF/RESET and adjust A3-R5 CW one or two turns.
f. Set H.V. control to OPERATE.
g. Repeat this cycle until audible buzz is heard and VOM reads $\approx$150 VDC. When the VOM reads greater than 120 VDC the undervoltage fault circuit will not be energized and A3-R5 can be further adjusted without resetting the H.V. control.

h. Adjust A3-R5 CW until audible buzz just disappears.
i. Adjust A3-R5 CCW until instability viewed on oscilloscope increases.
j. Adjust A3-R5 clockwise until the instability viewed on oscilloscope disappears. Then adjust R5 clockwise 3 full turns past this point. This completes adjustment of the current limit adj. R5.

6.3.4.11 Adjustment of -200V Overvoltage Trip Point

a. Turn off CB1. Set OPERATE switch to OFF/RESET. Wait 30 seconds.
b. Remove A3P1 from A3J1 of Switch Regulator PCB (A3).
c. Connect a jumper from A3-E7 to A3-E10 of switch regulator and a DVM/VOM from A3E7 to chassis.
d. Turn on CB1 and wait for STANDBY light.
e. Set HV control to OPERATE.
f. Record voltage on DVM/VOM.
g. Turn off CB1 and OPERATE switch.
h. Wait 30 seconds and then replace the jumper between A3-E7 and A3-E10 with a 56KΩ resistor.
i. Turn on CB1 and operate switch. Wait for BEAM ON light.
j. Adjust A3R53 CW until voltage drops to zero volts DC and logic returns to standby. If the trip point does not occur at 230 ± 10 VDC as the switch regulator output (as read on DVM/VOM) is adjusted upward using A3R53, reset the trip point by adjusting A2R38 on the Osc/Bias PWB.
k. Adjust A3R53 CCW three full turns.
l. Turn off CB1. Set OPERATE switch to OFF/RESET. Wait 30 seconds.
m. Replace the 56KΩ resistor from A3-E7 to A3-E10 with a jumper.
n. Turn on CB1 and OPERATE switch. Wait for BEAM ON light.

o. Adjust A3R3 to reading recorded in step f.
p. Turn off CB1, set HV control to OFF/RESET. Wait 30 seconds.
q. Remove jumper and meter from A3E7 to A3E10.
r. Reconnect A3P1 to A3J1.

6.3.4.12 Functional Check of Converter Overcurrent Trip Point

a. Turn off CB1. Wait 30 seconds.
b. Connect a jumper from the cathode of A4-CR13 to ground.
c. Turn on CB1 and wait for STANDBY light.
d. Set HV control to OPERATE - Fault Indicator on Front Panel will ligh t. A4CR13 will also light.
e. Turn off CB1. Set HV control to OFF/RESET. Wait 30 seconds. Remove Jumper.
f. Check the voltage across A4C12 as follows:
    1. Connect a voltmeter across A4C12.
    2. Turn on CB1.
    3. Check for 5.7 VDC.
    4. If not 5.7 VDC, adjust to 5.7 VDC using A4-R18.
g. Turn off CB1. Wait 30 seconds.
h. Remove DVM/VOM.

6.3.4.13 Functional Check of Helix Trip Point

a. Turn off CB1. Wait 30 seconds.
b. Connect positive lead of DVM to junction of A1R2/A1R3 (wiper). Connect negative lead to chassis.
c. Turn on CB1.
d. Read and record this voltage. Adjust A1-R3 fully counterclockwise. Wait for the STANDBY light on the Front Panel Indicator.
e. Set HV voltage control to OPERATE.

f. The BEAM ON indicator will light momentarily and the Fault light will light. This is a function check of logic drive signals only. Exact adjustment and check of helix trip circuit requires a special dummy load that can handle up to 1500 watts.

g. Adjust A1-R3 back to the voltage previously recorded.

h. If field adjustment of A1-R3 is required and a dummy load is not available, adjust R3 in accordance with the following values. Refer to Table 6-5 for Helix trip points for your particular TWTA.

Helix Trip Current (mA) (approximate)	Ref. Voltage (VDC) (approximate)
15	1.5
25	2.5
45	4.5
60	6.0

i. Turn off CB1. Set HV control to OFF/RESET. Wait 30 seconds.

j. Remove DVM/VOM.

k. This completes this functional check.

6.3.4.14 Adjust VSWR Trip Point (Option)

a. Turn off CB1.

b. Set up equipment to measure RF output using an RF dummy load capable of dissipating 450W CW (See Section 6.4). Set the frequency to the center of band.

c. Turn on CB1 and wait for STANDBY light.

d. Set HV control to OPERATE and monitor RF output.

e. Adjust the RF output until it is 10% of the rated output power for the TWTA under test. Do not increase RF drive above this point anytime during the procedure.

f. Set HV control to OFF/RESET.

g. Remove the RF dummy load and place an RF short at the output port of the TWTA. Keep the RF drive at the level set at step e.

h. Set HV control to OPERATE.

i. Adjust A1-R6 for VSWR trip at the RF power level set in step e.

j. Check the adjustment at both ends of the specified frequency range. The trip point should fall within 5% to 20% of rated output power.

k. This completes this procedure.

NOTE

This completes the routine adjustment procedure. Section 6.6 describes alternative procedures to handle special situations.

6.4 RF PERFORMANCE CHECK

Refer to Table 6-1 for test equipment required. Equipment with equivalent accuracies or capacities may be substituted for testing purposes; select all equipment for the proper frequency band.

1. Set up a microwave measurement circuit, such as the one shown in Figure 6-10.
2. Set the output of the microwave signal source to a minimum using the input variable attenuator.
3. Calculate the input microwave power needed to produce the output power specified on the data sheet, taking into account the specified gain. (The actual input power applied to the unit should never be more than 6 dB greater than the calculated value). Example:

Specified RF output	+50 dBm
Specified RF gain	37 dB
Maximum RF Input	+13 dBm

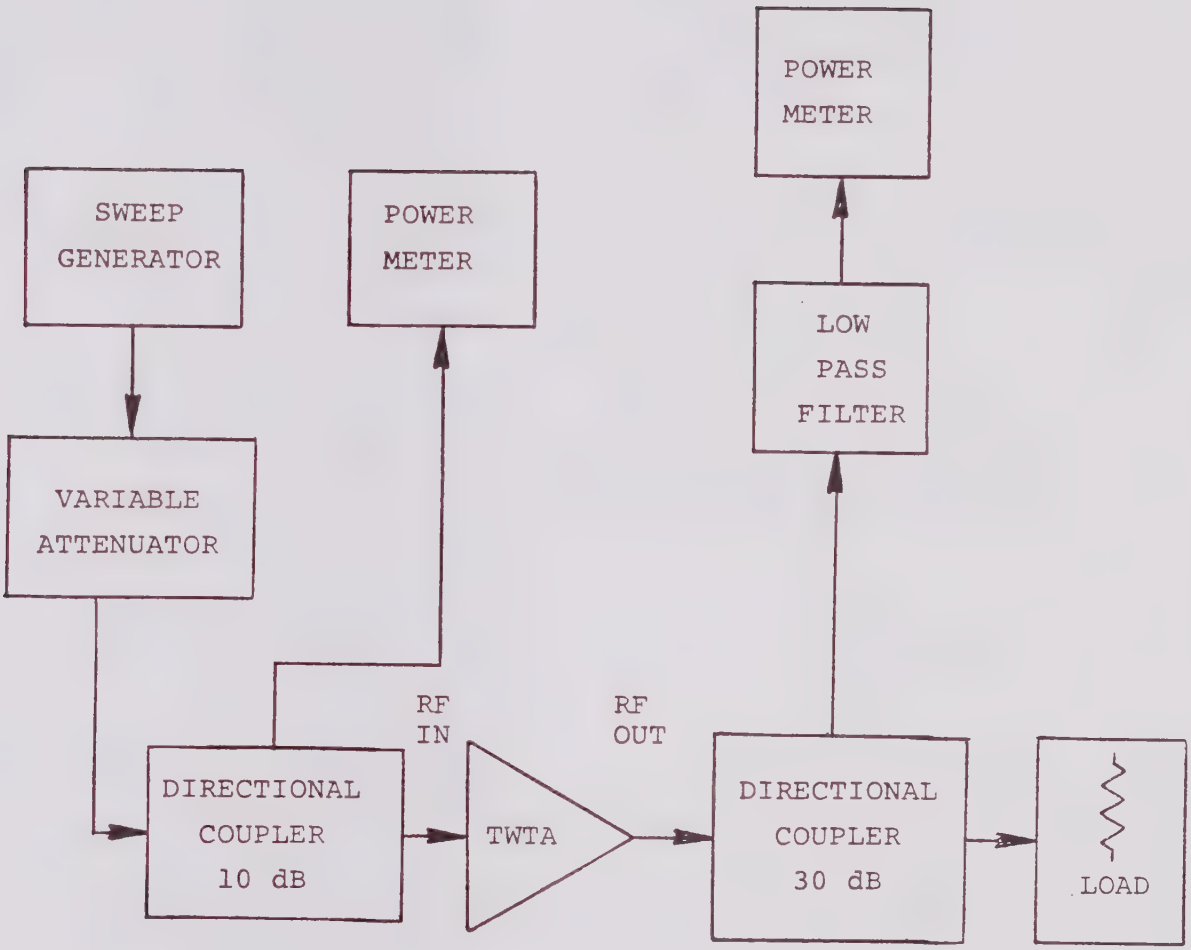


FIGURE 6-10

MICROWAVE MEASUREMENTS CIRCUIT

4. Apply AC line voltage to the system.
5. Test for gain as follows:
   a. Adjust the input microwave power to give the rated output power (i.e., 100W, 200W).
   b. Measure the input microwave power.
   c. Calculate the gain.

   Example:

Rated Output Power	+50 dBm
RF Input For Rated Output	+ 6 dBm
Actual RF Gain at Rated Output	+44 dB

6. Test for saturated output power as follows: Adjust the input power to maximize the output power. This saturated output value should exceed the power level specified on the data sheet.

6.5 CORRECTIVE MAINTENANCE AND TROUBLESHOOTING PROCEDURES

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WARNING

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LETHAL VOLTAGES UP TO 15 kV ARE PRESENT WHEN POWER IS APPLIED TO THE SYSTEM. BE EXTREMELY CAREFUL WHEN WORKING INSIDE THE UNIT. USE ONLY ONE HAND TO MAKE MEASUREMENTS OR ADJUSTMENTS. IF POSSIBLE TURN POWER OFF BEFORE MAKING ADJUSTMENTS. DO NOT ATTEMPT TO REPAIR OR TROUBLESHOOT THIS UNIT UNLESS YOU HAVE HAD EXPERIENCE IN SERVICING BOTH MICROWAVE AND HIGH VOLTAGE SYSTEMS.

****

6.5.1 General

The TWTA has been designed to facilitate rapid and easy maintenance. In addition to the indicators on the Front Panel, three internal LEDs have been installed as follows:

a. Two LEDs on the Oscillator Bias PWB (A2) Indicator Switch Regulator Overvoltage (A2-CR12) and Undervoltage A2CR26.
b. One LED on the HV Converter PWB A4 indicating HV overcurrent condition (A4-CR13).

The TWTA is shipped with a set of extension cables that can be used for maintenance. PWB's A2, A3 and A4 are designed to mount in extended position for ease of access during maintenance.

NOTE

Limit operation of the A2, A3 and A4 boards to 1/2 hour when in the extended position or they will overheat.

The Logic Board (A1) is designed with slots that mate with the lower mounting screws. The lower mounting screws are adjusted at the factory for a friction fit. (Figure 6-11)

CAUTION

Do not disturb the lower mounting bolts of the A1 Board. They do not have to be changed or loosened to remove the logic board.

The upper bolts of the logic board are removed, the board is slipped out and then the upper bolts are used to fasten the slotted end of the board for maintenance access.

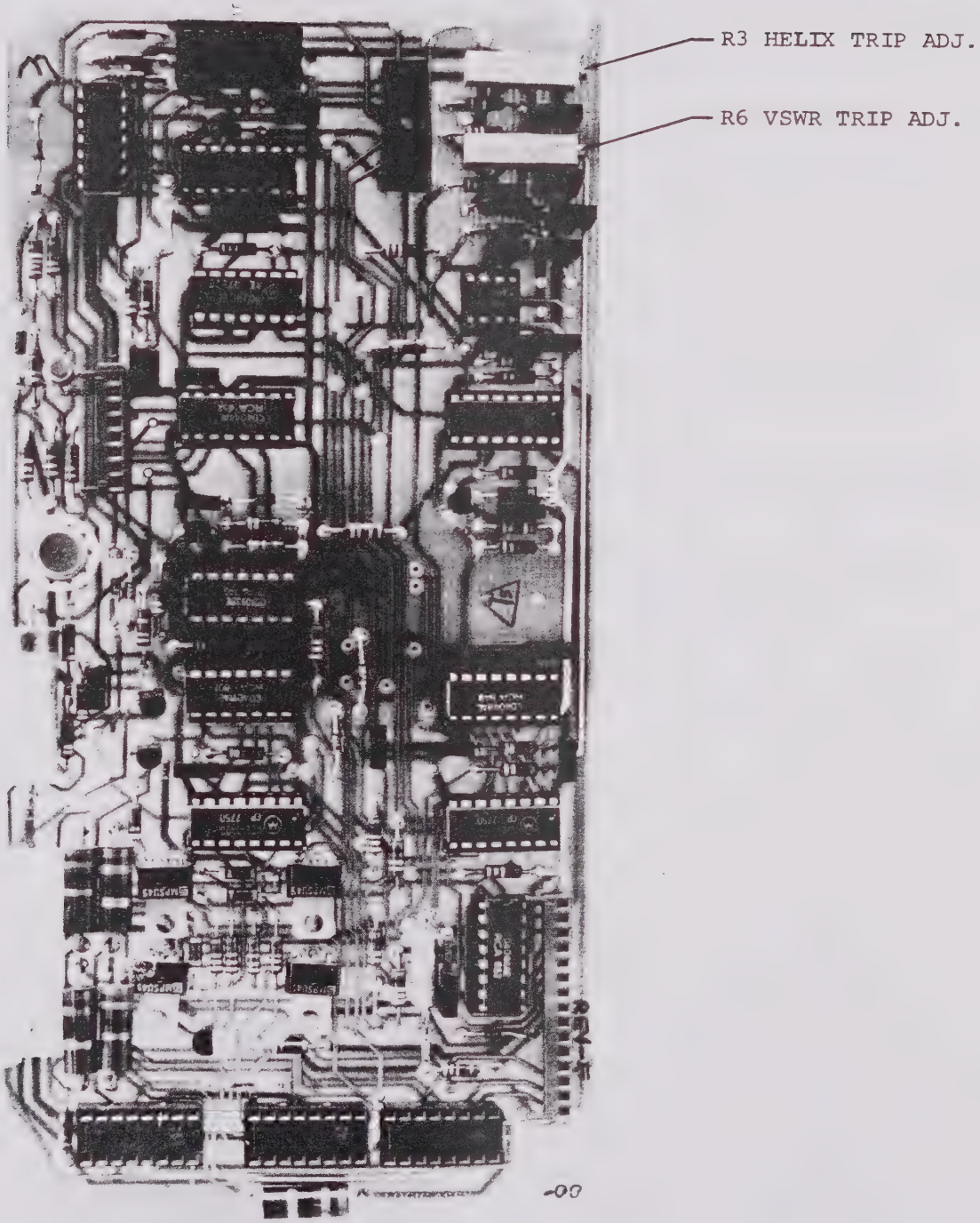


FIGURE 6-11 LOGIC CARD (A1)

NOTE

This TWTA is equipped with fast response fault detection circuits. If you "flip" the OPERATE/OFF/RESET Switch from on-to-off and back on again, you may induce faults that would mislead you in servicing the unit. When you turn HV off, wait 1 second to allow the charge in the switch regulator output capacitors to be dissipated then turn the HV on again. If there is a converter overcurrent fault indication after a very short prime power interruption, this is normal. Both the Fault and Power Supply Indicators will momentarily light and then be automatically cleared by the Fault Recycle Circuits.

6.5.2 Preliminary Check of HV Converter and HV Module (Figure 6-6)

This section will isolate problems in the HV converter or HV module.

a. Turn off CB1. Set HV Control to OFF/RESET. Wait 30 seconds.
b. Remove A4-P1, Figure 6-6, from A4J1-1 and remove A4-P3 from A4-J3 of HV Converter A4.
c. Connect jumper from A4J1-6 to chassis. (Helix fault defeat).
d. Connect jumper from A4J3-1 to chassis. (Switch regulator reference).
e. Obtain external power supply or other voltage source capable of 200 mA current and any voltage output up to a maximum voltage of 200 Vdc.
f. Connect the negative lead of the voltage source to A4J1-2 of the HV Converter A4 (Figure 6-6).
g. Connect the positive lead of the voltage source to A4J1-5 of HV Converter A4, Figure 6-6.
h. Connect oscilloscope from A4-TP-9 (or A4-J3-8) to chassis.

i. Connect jumper from A3-E7 (TP-8) to A3-E10 of Switch Regulator A3 to prevent the 200V overvoltage circuit from being energized when the switch regulator is operated at a no-load condition.

****

WARNING

****

APPLICATION OF 200VDC TO THE HIGH VOLTAGE MODULE IN A NO-LOAD CONDITION WILL GENERATE A 15 kV OUTPUT. EXTREME CAUTION IS REQUIRED TO AVOID PERSONNEL INJURY.

****

j. Turn on CB1. Wait for STANDBY light and then set HV control switch to OPERATE. Turn on external voltage source and set to minimum output. Slowly increase voltage source to a value $\leq$ 200 VDC. The 10 kHz ± 1.5 kHz square wave will have a peak amplitude equal to the voltage of the voltage source as seen on the oscilloscope.

k. Return the voltage source to zero volts DC and turn off HV control switch.

l. Connect oscilloscope to A4-TP-10 (or A4-J3-11). Repeat step j. then go to step m. Normal operation of the HV converter has been verified.

m. Turn off CB1. Set HV control to OFF/RESET. Wait 30 seconds.

n. Remove jumpers installed in steps c. and d.

o. Connect A4-P3 (Figure 6-4) to A4-J3 of HV converter.

p. Remove A5P1, P2, P3 from A5J1, J2, J3.

q. Repeat steps e through m, this verified operation of HV converter and HV module, then go to step r.

r. Remove external power supply.

s. This completes this procedure.

6.5.3 Additional Troubleshooting Procedures

Additional Troubleshooting procedures for the TWTA are presented in Table 6-6 in the form of charts that relate the symptoms to an assembly, schematic and probable cause. Waveforms for the switch regulator and converter are presented in Section 5. (See Table of Contents for a list of illustrations).

Much information is available in Section 6.3 relating to functional tests and adjustment procedures for the various PCB assemblies. These are designed so as to assist in isolating problems and it is recommended that this section be reviewed when troubleshooting is required.

TABLE 6-6

TROUBLESHOOTING PROCEDURES

	SYMPTOM	ASSEMBLY	SCHEMATIC	CHECK
1.	No indicator lit on front panel indicator	TWTA	UD1	Check input voltage, CB1.
		C2		Check for 45 Vdc across C2.
		C1		Check for 300 Vdc across C1.
		Osc Bias PWB	A2	Check for 29 Vac TP1 and TP2 to ground* J4-3 and 5 to ground**
		Osc Bias PWB	A2	Check for 12 Vdc TP3 to ground* A2J7-10 to ground**
2.	No time delay	Logic PWB	A1	Check for +12 Vdc TP3 to ground* A1J7-10 to ground**
		Logic PWB	A1	Check voltage A1U2-9, +12 Vdc when time delay over.
3.	No standby	Logic PWB	A1	In time delay, a fault exists.
4.	No BEAM ON at switch command			Check 1 above, a fault exists.
		TWTA	UD1	Check C1 (-) negative to ground. Read 300 Vdc. If < 10 Vdc, check LED CR12 on Osc Bias PCB (A2).
		Converter PWB	A4	Check for 10 kHz square wave TP1 to ground* A4J2-3 to ground** and A4TP2 to ground* A4J2-5 to ground** Check LED CR13 on A4. If lit, indicates converter overload.
		Logic PWB	A1	A1J7-13 to ground. Read 12 Vdc. If < 1 Vdc, indicates 38V or 250V shut down circuit is energized.

TABLE 6-6 (CONT'D)

	SYMPTOM	ASSEMBLY	SCHEMATIC	CHECK
5.	Fault	Osc Bias PWB	A2	Check LEDs CR12, CR26.
		Converter PWB	A4	Check LED CR13.
		Control Logic	A1	Determine particular fault by checking for a low voltage < 1 Vdc on the following: U1-6 Summary fault from power supply U-12 TWT temperature U4-14 Remote Interlock U4-12 Cover Interlock U9-6 Reflected fault U4-7 Helix fault U10-5 Low line inhibit
6.	Helix Current Fault	TWTA	UD1	Disconnect TWT from HV module. Check helix current trip point adjust.
7.	Converter Overload Fault	Converter PWB	A4	LED CR13 lit, check for TWT failure or HV module failure.
8.	250 V Over-Voltage Shutdown	Osc Bias PWB	A2	LED CR12 lighted.
		Switch Regulator	A3	Check load on switch regulator. If HV module is disconnected, E7 and E10 on switch regulator must be jumpered before switch regulator will turn on at NO LOAD condition without tripping overvoltage protection circuit. Turn off CB1. Connect VOM across C1 (+) and C1 (-). Turn on CB1. If voltage comes on and then falls to zero, check Q6 or Q7 on switch regulator for short.

TABLE 6-6 (CONT'D)

	SYMPTOM	ASSEMBLY	SCHEMATIC	CHECK
9.	Undervoltage Shutdown	Osc Bias PWB	A2	LED CR26 lighted. Check output of switch regulator PCB for short circuit or misadjustment of R5 on switch regulator PCB.
		Switch Regulator	A3	Check adjustment of current limit circuit. See manual for adjustment procedure.
10.	Filament Voltage	HV Module	A5	Check for 6.3 Vdc from A1E10 to A2E10.
11.	No RF Output	TWTA	UD1	Check the fittings for a tight connection. Check for voltages applied to the TWT. Check to see that the RF variable attenuator is adjusted fully clockwise. Check the load VSWR. Check the termination in the output and input isolators for discoloration indicating excessive power or VSWRs. Change the TWT.

6.6 ALTERNATIVE ADJUSTMENT PROCEDURES

The following procedures allow the heater, helix and collector voltages to be adjusted when a Varian H.V. Monitor is not available.

****

WARNING

****

THE FOLLOWING PROCEDURES INVOLVE A HIGHER POTENTIAL HAZARD TO PERSONNEL THAN THOSE IN SECTION 6.3.4. VARIAN STRONGLY RECOMMENDS THE USE OF THE VARIAN H.V. MONITOR IF AT ALL POSSIBLE.

****

6.6.1 Alternate Method-High Voltage Module A5 No-Load Check When High Voltage Monitor Not Available

Refer to the Test Data Package for specific No-Load Voltages. Use this procedure when TWT has not been changed. Proceed as follows:

a. Turn off CB1. Set HV Control to OFF/RESET. Wait 30 seconds.
b. Connect DVM to A3E7 (TP-8) of Switch Regulator A3 and chassis (Figure 6-5). Remove A5P1, P2 and P3 from A5J1, J2, J3.
c. Defeat interlock switches. Turn on CB1 and wait for STANDBY condition.
d. Set HV Control to OPERATE and read voltage on Switch Regulator output. Adjust A3-R53 to obtain Switch Regulator output corresponding to helix-to-cathode no-load voltage given in Test Data Package. The helix-to-cathode voltage will not be ±1% of the voltage recorded on the Test Data Package for no-load conditions.

NOTE

This procedure assumes the HV Module involved is the one originally supplied with your TWTA or a replacement unit with same tap arrangement.

e. Turn off CB1. Set HV Control to OFF/RESET. Wait 30 seconds.
f. Remove DVM and reinstall A5P1, P2 and P3 in A5J1, J2, J3.

6.6.2 Alternate Method-High Voltage Module A5 Full-Load Check With No High Voltage Monitor Available.

Refer to the Test Data Package for specific full-load voltages. Use this procedure when TWT has not been changed. Proceed as follows:

Repeat steps 6.6.1a. through f. eliminating the portion of the procedure involving A5P1, P2, P3 and using the full-load voltages given in the Test Data Package.

6.6.3 Alternate Method-Heater Voltage Measurement

If no H.V. Monitor is available, the following procedure can be used to measure heater voltage:

****

WARNING

****

THIS IS A POTENTIALLY RISKY PROCEDURE IF THE H.V. IS TURNED ON FOR ANY REASON. DO NOT TURN ON THE H.V. TAPE THE H.V. CONTROL IN THE OFF/RESET POSITION.

BE CAREFUL TO AVOID CONTACT WITH THE RFI FILTER ADJACENT TO THE H.V. MODULE BECAUSE IT IS LIVE WITH LINE VOLTAGE POTENTIAL OF 120 OR 230 VAC WHENEVER THE TWTA IS CONNECTED TO THE PRIME POWER DISTRIBUTION SYSTEM.

****

a. Turn off CB1. Set HV Control to OFF/RESET and tape in place. Wait 30 seconds.
b. Remove A4P1 from A4J1 on input converter PCB A4 (Figure 6-6). This prevents the HV from accidentally being applied while measuring the heater voltage.
c. Remove cover from HV Module. Locate E1 on PCB #2(A5A2) (Figure 6-10). Connect positive lead of 10 VDC DVM/VOM to A5A2-E1.
d. Locate E10 on PCB #2 assembly (A5A2), (Figure 6-10). Connect negative lead of DVM/VOM to A5A2-E10.
e. Depress and release the interlock switches.
f. Turn on CB1. The voltmeter will read less than 6.3 VDC. As the timing cycle is completed (about 3 min.) the voltage will increase to 6.35 VDC ± .1 VDC. If, after the timing cycle is complete and the logic is in STANDBY, the DVM/VOM reads other than 6.35 VDC ± .1 VDC, locate A4R2 on the H.V. Converter PWB A4 (Figure 6-6) and adjust A4R2 to read 6.35 VDC ± .1 VDC on the DVM/VOM.
g. Turn off CB1. Wait 30 seconds.
h. Remove the DVM/VOM. Replace the cover on the H.V. Module.
i. Reinstall A4-P1 into A4-J1 on PCB A4. Remove the tape from the HV Control.
j. This completes this procedure.

6.6.4 Alternate Method-H.V. No-Load Check

If an H.V. Monitor is not available and TWT has been changed, proceed as follows:

a. Turn off CB1. Set HV Control to OFF/RESET. Wait 30 seconds.

****

WARNING

****

THIS PROCEDURE CAN BE RISKY BECAUSE IT INVOLVES OPENING THE H.V. MODULE WHICH GENERATES VOLTAGES TO 15 KV. STAY PHYSICALLY CLEAR OF THE H.V. MODULE AND MAKE SURE EVERYONE ELSE IS CLEAR BEFORE TURNING THE H.V. ON.

b. Depress and release the interlock switches to remove interlock defeat.
c. Remove the top cover of the HV Module A5 (Figure 6-6).
d. Connect the High Voltage lead of the HV Divider to A5A1E10 of PWB #1 (A5A1) Figure 6-8.
e. Connect reference lead of divider to chassis. Connect DVM to the divider output.
f. Remove A5P1,P2 and P3 from A5J1,J2,J3.
g. Turn on CB1.
h. Defeat the interlock switch by pulling stem out. Wait 3 minutes. Set HV Control to OPERATE.
i. Record the voltage measured.
j. If helix voltage measured is incorrect, adjust to proper value using A3R53 on the Switch Regulator PWB.
k. Set HV Control to OFF/RESET.
l. Turn off CB1. Wait 30 seconds.
m. Depress and release the interlock switches.
n. Remove the HV Divider.
o. Replace the HV Module Cover.
p. Reinstall A5P1,P2,P3 into A5J1,J2,J3.
q. This completes this procedure.

6.6.5 Alternate Method-Final Adjustment of Helix Voltage, Collector Voltage

If H.V. Monitor is not available, and TWT has been changed, proceed as follows:

NOTE

This procedure is very similar to 6.6.4 with the TWT left connected and the collector voltage as well as the helix voltage measured.

a. Repeat 6.6.4a. through o. except for step f.
b. Move H.V. Divider to A1E5 with the reference lead connected to chassis. Refer to table 6-5 for collector voltage for TWT type used in unit.
c. Turn on CB1. Wait 3 minutes for STANDBY. Set H.V. Control to OPERATE.
d. Record the measured voltage. This value is the collector-to-helix voltage.

NOTE

The collector-to-cathode voltage is equal to the measured helix voltage (6.6.4 i.) minus the value recorded in step d.

e. Refer to Table 6-5 for allowable collector-cathode voltage. If the collector-to-cathode voltage is incorrect, the taps will have to be changed. (This should not be the case unless the TWT or the HV module has been replaced).

****

WARNING

****

DO NOT CHANGE TAPS AT THIS POINT

****

NOTE

See Section 6.3.4.8 for the procedure involving tap changes.

f. If the collector taps are changed, repeat this section.
g. Turn off CB1. Set HV Control to OFF/RESET. Wait 30 seconds.
h. Remove H.V. Divider and reinstall H.V. Module Cover.
i. This completes this procedure.

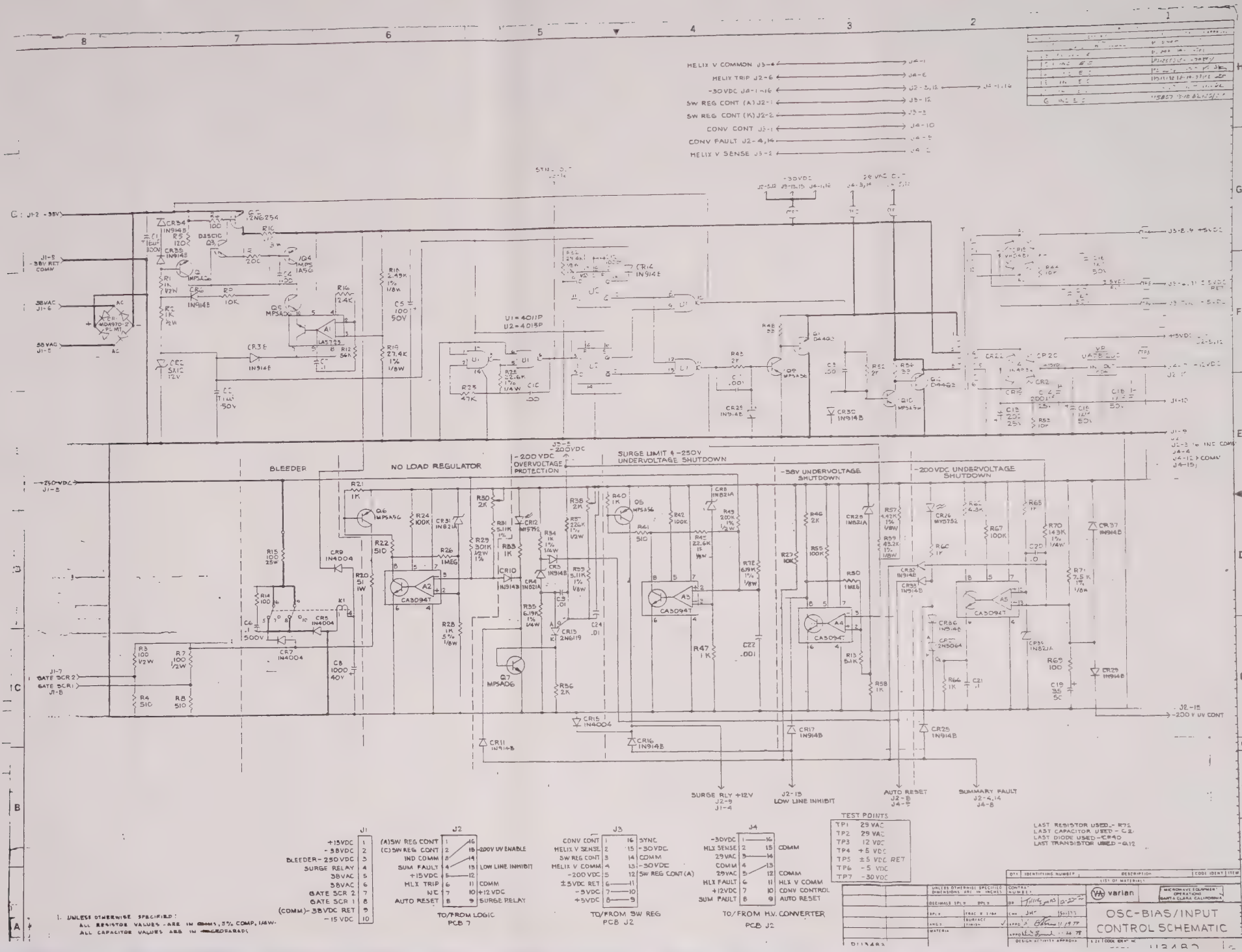
SECTION 7

DRAWINGS AND SCHEMATICS

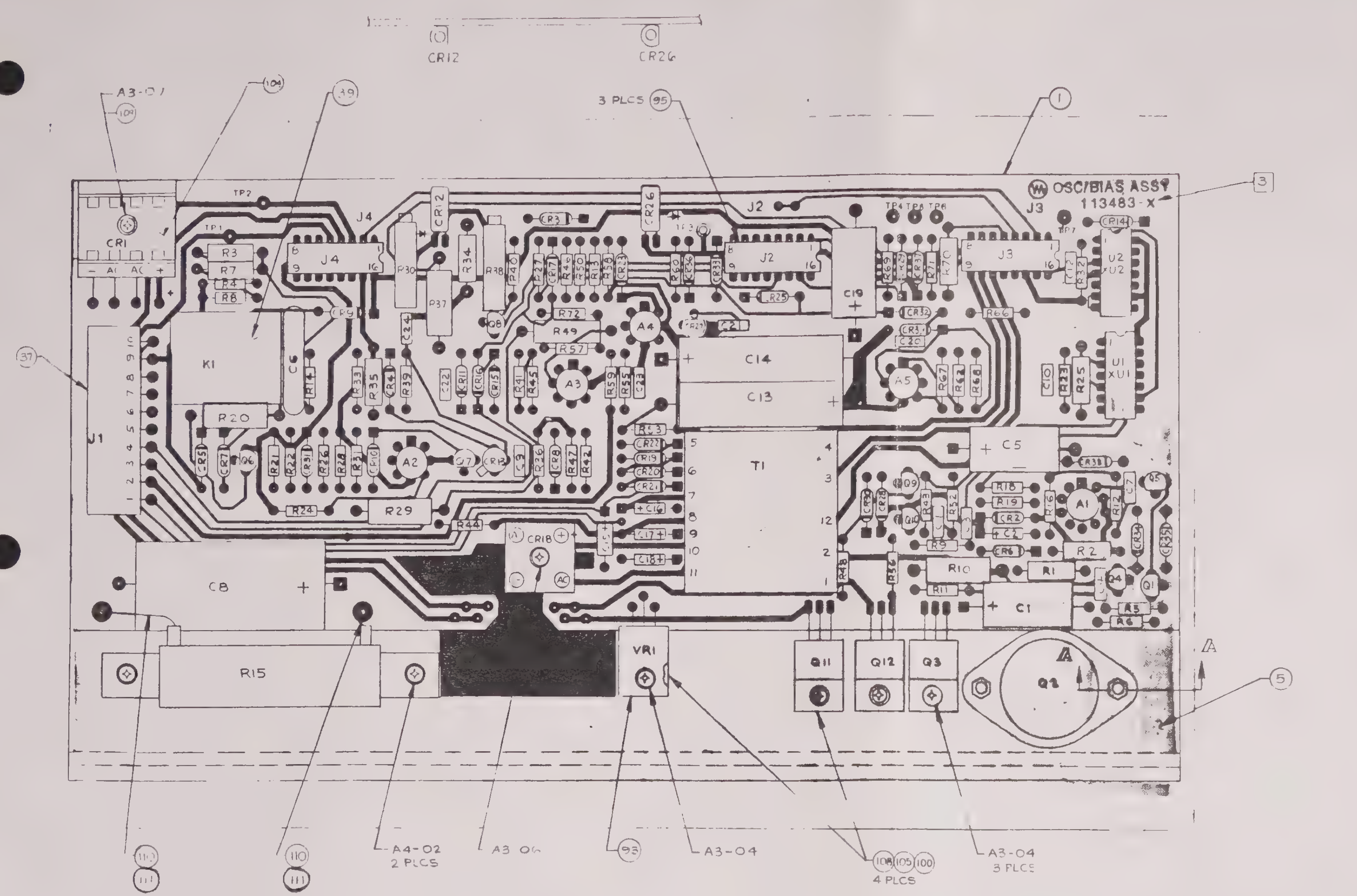
	Assembly, 100/200W TWTA	C133600-65
	Schematic, RF	C134983
UD1	Assembly, 100/200W TWTA Power Supply	E113979
UD1	Outline, 100/200W TWTA	D113850
UD1	Schematic, 100/200W TWTA Power Supply	J129820
UD1A1	Logic PWB Assembly	D129079
UD1A1	Schematic, Logic PWB	E129076
UD1A2	Oscillator/Bias PWB Assembly	D113483
UD1A1	Schematic, Oscillator/Bias PWB	E113480
UD1A3	Switch Regulator PWB Assembly	D113849
UD1A3	Schematic, Switch Regulator PWB	D113846
UD1A4	HV Converter/Heater Supply PWB Assembly	D129405
UD1A4	Schematic, HV Converter/Heater Supply PWB	D129402
UD1A5	High Voltage Module Assembly	D113919
UD1A5	Schematic, High Voltage Module	D113907
UD1A5A1	PCB #1 H.V. Module Assembly	D113906
UD1A5A1	Schematic, PCB #1 H.V. Module	See 1A5
UD1A5A2	PCB #2 H.V. Module Assembly	D113902
UD1A5A2	Schematic, PCB #2 H.V. Module	See 1A5
UD1A8	Fault/Recycle Board Assembly	C129083
UD1A8	Schematic, Fault/Recycle Board	See 1A1
UD1-3	Front Panel Assembly	D129054

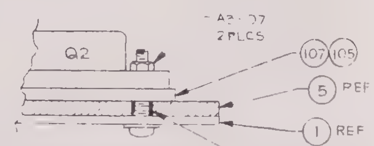
The parts lists for these drawings are separate documents that carry the same drawing number, i.e., LM113979 is the bill of materials for drawing E113979.

NOTE: ABOVE LISTED DRAWINGS ARE FILED IN NUMERICAL ORDER.


HELIX V COMMON J3-4
HELIX TRIP J2-6
-30VDC J4-1,16
SW REG CONT (A) J2-1
SW REG CONT (K) J2-2
CONV CONT J3-1
CONV FAULT J2-4,14
HELIX V SENSE J3-2
BLEEDER
NO LOAD REGULATOR
-200 VDC OVERVOLTAGE PROTECTION
SURGE LIMIT & -250V UNDERVOLTAGE SHUTDOWN
-38V UNDERVOLTAGE SHUTDOWN
-200VDC UNDERVOLTAGE SHUTDOWN
SURGE RLY +12V J2-9 J1-4
J2-13 LOW LINE INHIBIT
AUTO RESET J2-8 J4-9
SUMMARY FAULT J2-4,14 J4-8
J1
+15VDC 1
-38VDC 2
BLEEDER-250VDC 3
SURGE RELAY 4
38VAC 5
38VAC 6
GATE SCR 2 7
GATE SCR 1 8
(COMM)-38VDC RET 9
-15 VDC 10
J2
(A)SW REG CONT 1
(C)SW REG CONT 2
IND COMM 3
SUM FAULT 4
+15VDC 5
HLX TRIP 6
NC 7
AUTO RESET 8
16 -200V UV ENABLE
14
13 LOW LINE INHIBIT
12
11 COMM
10 +12 VDC
9 SURGE RELAY
TO/FROM LOGIC PCB 7
J3
CONV CONT 1
HELIX V SENSE 2
SW REG CONT 3
HELIX V COMM 4
-200 VDC 5
±5VDC RET 6
-5VDC 7
+5VDC 8
16 SYNC
15 -30VDC
14 COMM
13 -30VDC
12 SW REG CONT (A)
11
10
9
TO/FROM SW REG PCB J2
J4
-30VDC 1
HLX SENSE 2
29VAC 3
COMM 4
29VAC 5
HLX FAULT 6
+12VDC 7
SUM FAULT 8
16
15 COMM
14
13
12 COMM
11 HLX V COMM
10 CONV CONTROL
9 AUTO RESET
TO/FROM H.V. CONVERTER PCB J2
TEST POINTS
TP1 29 VAC
TP2 29 VAC
TP3 12 VDC
TP4 +5 VDC
TP5 ±5 VDC RET
TP6 -5 VDC
TP7 -30 VDC
LAST RESISTOR USED - R72
LAST CAPACITOR USED - C2
LAST DIODE USED - CR40
LAST TRANSISTOR USED - Q12
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTOR VALUES ARE IN OHMS, 5% COMP, 1/4W.
ALL CAPACITOR VALUES ARE IN MICROFARADS
varian
MICROWAVE EQUIPMENT OPERATIONS SANTA CLARA CALIFORNIA
OSC-BIAS/INPUT CONTROL SCHEMATIC
113480

ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	C	[illegible]	[illegible]2945	1-11-78	[illegible]
	D	REVISED / EC	[illegible]12478	4 7 78	[illegible]
	F	INC / EO	[illegible]	5-1-78	[illegible]
	[illegible]	[illegible] E [illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible] E [illegible]	[illegible]	[illegible]	[illegible]
	H	INC E C	PS12923	12-18-78	TG
	I	INC E C	[illegible]3012	3-12 79	[illegible]
	[illegible]	[illegible] E C	[illegible]13119	8 14 79	[illegible]
	L	[illegible] E C	[illegible]13192	8-14 79	[illegible]
	M	INC. E O	[illegible]14727	[illegible] 12 81	NA/ HT
	N	INC E C	[illegible]14834	[illegible] 12 81	NA
	P	INC E O	15807	3 18 82	JS





DETAIL A-A

SEE SEPARATE LIST OF MATERIALS - LM113483

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

NEXT ASSEMBLY	USED ON
E113979	TWTA

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

DECIMALS 1PL ± .1 2PL ± .02

ANG ± 1°

SURFACE FINISH

MATERIAL

SPEC NO

FINISH

CONTRACT NUMBER

CUSTOMER APPROVAL

varian

MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA CALIFORNIA

ASSEMBLY
OSCILLATOR/BIAS PCB

SIZE D | CODE IDENT NO | 113483 | P

SHEET 1 OF 7

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE: OSC/BIAS PCB ASSY.	LM 113483	REV. P
CODE IDENT NO. 59782	APPROVAL Lowell Penn DATE Dec 9, 1977	[illegible] 1-26-78	0325 H	

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
E113979	100/200W		A	REVISED PER ENG. REQUEST	-	12-6-77	[illegible]
E113979			B	ITEM 76 WAS 28.7K, #31-610001	-	1-6-78	[illegible]
			C	ADDED ITEM 108; RELEASED TO PRODUCTION	PS12345	1-16-78	[illegible]
			D	INC / E.O.	PS12478	5-1-78	[illegible]
			E	INC / E.O.	PS12552	5-1-78	[illegible]
			F	INC E.O	PS12595	10-[illegible]	[illegible]
			G	INC. E.O.	PS12806	10-30-78	[illegible]
			H	INC E.O.	PS12923	[illegible]	[illegible]
			J	INC E.O	PS13012	3-12-79	[illegible]
			K	INC E.O.	PS13119	8-14-79	[illegible]
			L	INC E.O	PS13192	8-14-79	[illegible]
			M	INC. E.O	PS14727	5-12-81	NA
			N	INC. E.O	PS14834	5-12-81	NA
			P	INC EO	15807	3-18-82	JS

REVISION STATUS

SHEET																										
LTR																										
SHEET																										
LTR																										
SHEET																										
LTR																										

FORM 1758-01-375

MICROFILM

varian | MICROWAVE EQUIPMENT OPERATIONS | OSC/BIAS PCB ASSY. | LM 113483 | REV P

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
1		FAB.OSC/BIAS PCB	D113482			1			
2									
3		SCHEMATIC	E113480			REF			
4									
5		HEATSINK	D129026			1			
6									
7	A1	I.C.-VOLTAGE REGULATOR	62-600711	LAMBDA	LAS-723	1			
8	A2-A5	I.C.-AMPLIFIER	62-600676	RCA	CA3094T	4			
9									
10	C10	CAPACITOR, CER., .001μf, 2%, 200V	41-119986			1			
11	C1	CAPACITOR, ELECT., 6μF, 100V	41-505818	SPRAGUE	500D605F100CC7	1			
12	C2, C15-18	CAPACITOR, TANT., 1μF, 50V	41-606802	SPRAGUE	CS13BG105K	5			
13	C3,4, 11,22,23	CAPACITOR, CERAMIC, .001μF, 200V	41-229953		CK05BX102K	5			
14	C5	CAPACITOR, ELECT., 25μF, 50V	41-505819	SPRAGUE	500D256G050CC7	1			
15	C6	CAPACITOR, CERAMIC, .1μF, 500V	41-256900	SPRAGUE	5GA-P10	1			
16	C7,21	CAPACITOR, CERAMIC, .1μF, 100V	41-229952		CK06BX104K	3			
17	C8	CAPACITOR, ELECT., 1000μF, 40V	41-505891	SIEMENS	82000 B41010-1000/40/	1			
18	C9,24	CAPACITOR, CERAMIC, .01μF, 200V	41-229951		CK06BX103K	2			
19	C12	CAPACITOR, CERAMIC, 100pF, 200V	41-229960		CK05BX101K	1			
20	C13,14	CAPACITOR, ELECT., 200μF, 25V	41-506008	SPRAGUE	500D207G025DH7	2			
21	C19	CAPACITOR, ELECT., 35μF, 50V	41-506003	SPRAGUE	500D356G050DC7	1			

varian | MICROWAVE EQUIPMENT OPERATIONS | OSC/BIAS PCB ASSY. | LM 113483 | REV R

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
22	C20	CAPACITOR, CERAMIC, .01µF, 200V	41-229951		CK06BX103K	1			
23									
24									
25	CR1	DIODE, BRIDGE	66-230613	MOTOROLA	MDA970-2	1			
26	CR2	DIODE, ZENER, 12V	66-393298	SEMTECH	SX12	1			
27	CR3,6,10, 11,14,16, 17,25, 28-30,32-38	DIODE, SIGNAL	66-320914		1N914B	18			
28	CR4,8,23, 31,39	DIODE	66-310821		1N821A	5			
29	CR5,7, 9,15	DIODE, RECTIFIER	66-304004		1N4004	4			
30	CR12,26	DIODE, LED-RED	67-499834	MONSANTO	MV5752	2			
31	CR13	UNIJUNCTION	62-906119		2N6119	1			
32	CR18	DIODE, BRIDGE	66-235014	VARO	VH-048X	1			
33	CR19-22	DIODE, RECTIFIER	66-304936		1N4936	4			
34	CR27	DIODE, SCR	66-600088		2N5064	1			
35									
36									
37	J1	CONNECTOR, 10 PIN	51-407160	MOLEX	09-75-1101	1			
38									
39	K1	RELAY	72-115933	POTTER & BRUMFIELD	R10E2-Y2-J2.5K	1			
40									
41									

varian | MICROWAVE EQUIPMENT OPERATIONS | OSC/BIAS PCB ASSY. | LM 113483 | REV P

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO -00	-01	-02	-03
42	Q1,5,7	TRANSISTOR, NPN	62-920018	MOTOROLA	MPS A06	3			
43	Q2	TRANSISTOR, NPN	62-906254	RCA	2N6254	1			
44	Q3	TRANSISTOR, PNP	62-798021	GE	D45C10	1			
45	Q4,6 8-10	TRANSISTOR, PNP	62-920019	MOTOROLA	MPS A56	5			
46	Q11,12	TRANSISTOR NPN	62-798003	GE	D44H11	2			
47									
48									
49									
50	R1,R2	RESISTOR, COMP, 1K, 1/2W, 5%	32-201410		RC20GF102J	2			
51	R3,7	RESISTOR, COMP, 100Ω, 1/2W, 5%	32-201310		RC20GF101J	2			
52	R4,8, 22,41	RESISTOR, COMP, 510Ω, 1/4W, 5%	32-301351		RC07GF511J	4			
53	R5	RESISTOR, COMP, 120Ω, 1/4W, 5%	32-301312		RC07GF121J	1			
54	R6, 14,69	RESISTOR, COMP, 100Ω, 1/4W, 5%	32-301310		RC07GF101J	3			
55	R9	RESISTOR, COMP, 10K, 1/4W, 5%	32-301510		RC07GF103J	1			
56	R10	RESISTOR, W.W., .15Ω, 3W, 3%	31-599708	DALE	RS-2B	1			
57	R11	RESISTOR, COMP, 200Ω, 1/4W, 5%	32-301320		RC07GF201J	1			
58	R12	RESISTOR, COMP, 56K, 1/4W, 5%	32-301556		RC07GF563J	1			
59	R13	RESISTOR, COMP, 5.1K, 1/4W, 5%	32-301451		RC07GF512J	1			
60	R15	RESISTOR, W.W., 100Ω, 25W, 5%	35-497310	OHMITE	0200F	1			
61	R16	RESISTOR, COMP, 2.4K, 1/4W, 5%	32-301424		RC07GF242J	1			
62	R71	RESISTOR, M.F., 7.5 K, 1/8W, 1%	31-60[illegible]	DALE	RN60[illegible]	1			

varian | MICROWAVE EQUIPMENT OPERATIONS | OSC/BIAS PCB ASSY. | LM 113483 | REV P

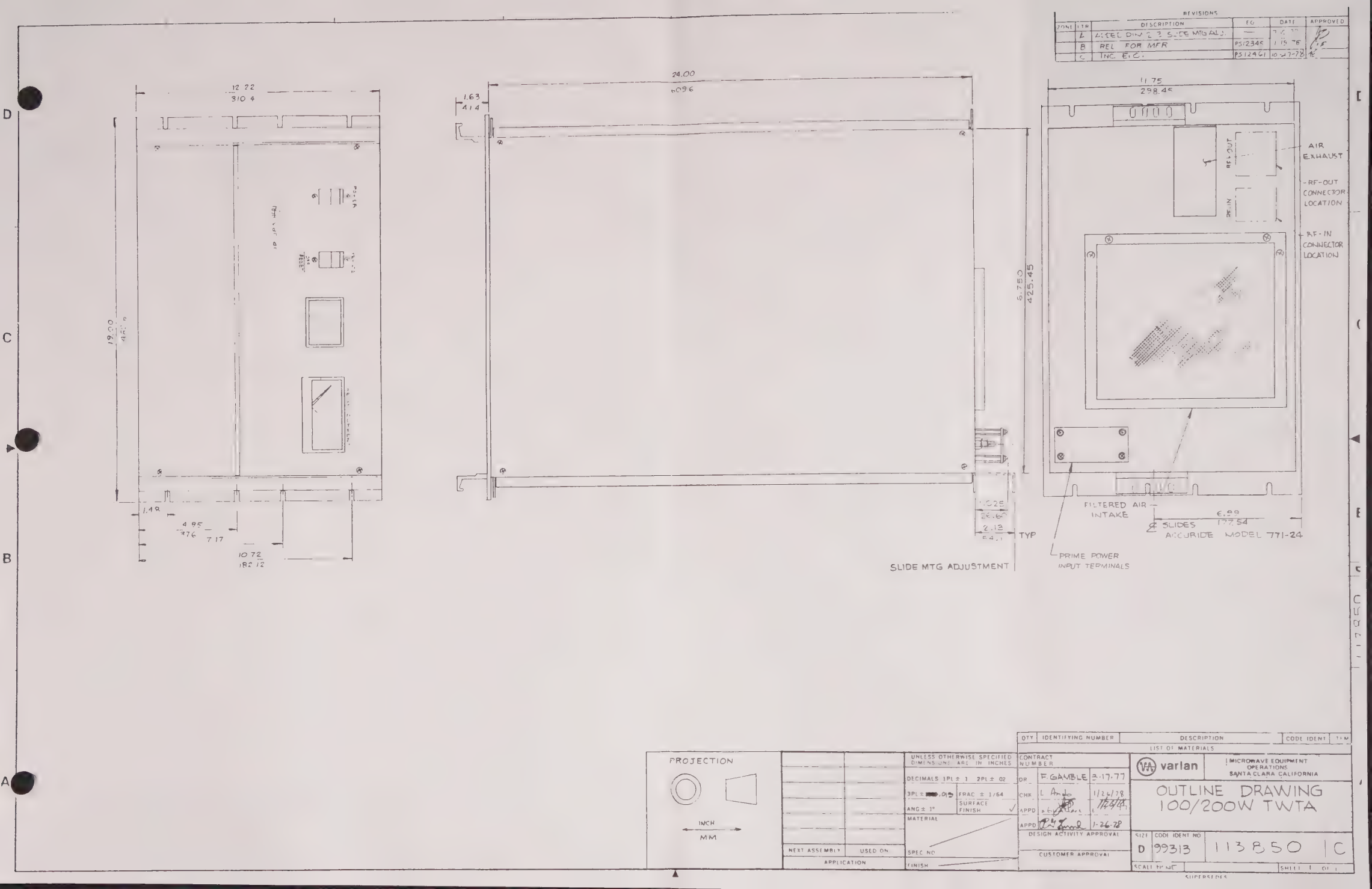
ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
63	R18	RESISTOR, M.F., 2.49K, 1/8W, 1%	31-610088	DALE	MF-1/10-T2	1			
64	R19	RESISTOR, M.F., 27.4K, 1/8W, 1%	31-610201		RNR552742FP	1			
65	R20	RESISTOR, COMP, 51Ω, 1W, 5%	33-301251		RC32GF510J	1			
66	R21,33,40 47,28,58 60,66,68	RESISTOR, COMP, 1K, 1/4W, 5%	32-301410		RC07GF102J	9			
67	R23	RESISTOR, COMP, 47K, 1/4W, 5%	32-301547		RC07GF473J	1			
68	R24,42 55,67	RESISTOR, COMP, 100K, 1/4W, 5%	32-301610		RC07GF104J	4			
69	R25	RESISTOR, M.F., 22.6K, 1/4W, 1%	31-605226		RN60C	1			
70	R26, 50	RESISTOR, COMP, 1 MEG, 1/4W, 5%	32-301710		RC07GF105K	2			
71	R27 44,53	RESISTOR, COMP, 10K, 1/4W, 5%	32-301510		RC07GF103J	3			
72	R45	RESISTOR M.F. 22.6K 1/8W 1%	31-610092	DALE	MF-1/10-T2	1			
73	R29	RESISTOR, M.F., 301K, 1/2W, 1%	31-610101		RN65C3013F	1			
74	R30,38	RESISTOR, VARIABLE, 2K, 3/4W, 10%	36-792211	BOURNS	3006P-1-202	2			
75	R31,39	RESISTOR, M.F., 5.11K, 1/8W, 1%	31-610050	DALE	MF-1/10-T2	2			
76	R32	RESISTOR, M.F., 29.4K, 1/4W, 1%	31-225-294	DALE	MF-1/10-T2	1			
77	R34	RESISTOR, M.F., 1K, 1/4W, 1%	31-604100		RN60C	1			
78	R35,R72	RESISTOR, M.F., 6.19K, 1/4W, 1%	31-604619		RN60C	2			
79	R36,43 46,52	RESISTOR, COMP, 2K, 1/4W, 5%	32-301420		RC07GF202J	4			
80	R37	RESISTOR, M.F., 226K, 1/2W, 1%	31-610103		RN65C2263F	1			
81	R48,56	RESISTOR, COMP, 33Ω, 1/4W, 5%	32-301233		RC07GF330J	2			
82	R49	RESISTOR, M.F., 200K, 1/2W, 1%	31-614804	DALE	MMF-¼-T2	1			

varian | MICROWAVE EQUIPMENT OPERATIONS | OSC/BIAS PCB ASSY. | LM 113483 | REV P

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. 00	-01	-02	-03
83	R59	RESISTOR, M.F., 24.3K, 1/8W, 1%	31-610090	DALE	MF-1/10-T2	1			
84	R62	RESISTOR, COMP, 4.3K, 1/4W, 5%	32-301443		RC07GF432J	1			
85	R70	RESISTOR, M.F., 143K, 1/4W, 1%	31-226143		RN60C	1			
86	R57	RESISTOR, M.F., 4.42K, 1/4W, 1%	31-604442		RN60C	1			
87									
88	T1	TRANSFORMER	C113997			1			
89									
90	U1	I.C.-QUAD2-INPUT NAND	62-600728	FAIRCHILD	4011P	1			
91	U2	I.C.-FLIP FLOP	62-600729	FAIRCHILD	4013P	1			
92									
93	VR1	VOLTAGE REGULATOR +12V	62-600495	FAIRCHILD	7812UC	1			
94									
95	XJ2-J4	SOCKET, I.C., 16 PIN	54-634023	CIRCUIT ASSEMBLY	CA-16S-10SD	3			
96									
97									
98									
99	XU1,XU2	SOCKET, I.C., 14 PIN	54-634007	SAE	CSA3100-14B	2			
100		WASHER, SHOULDER	14-998043	SEASTROM	5607-45	4			
101									
102									
103									

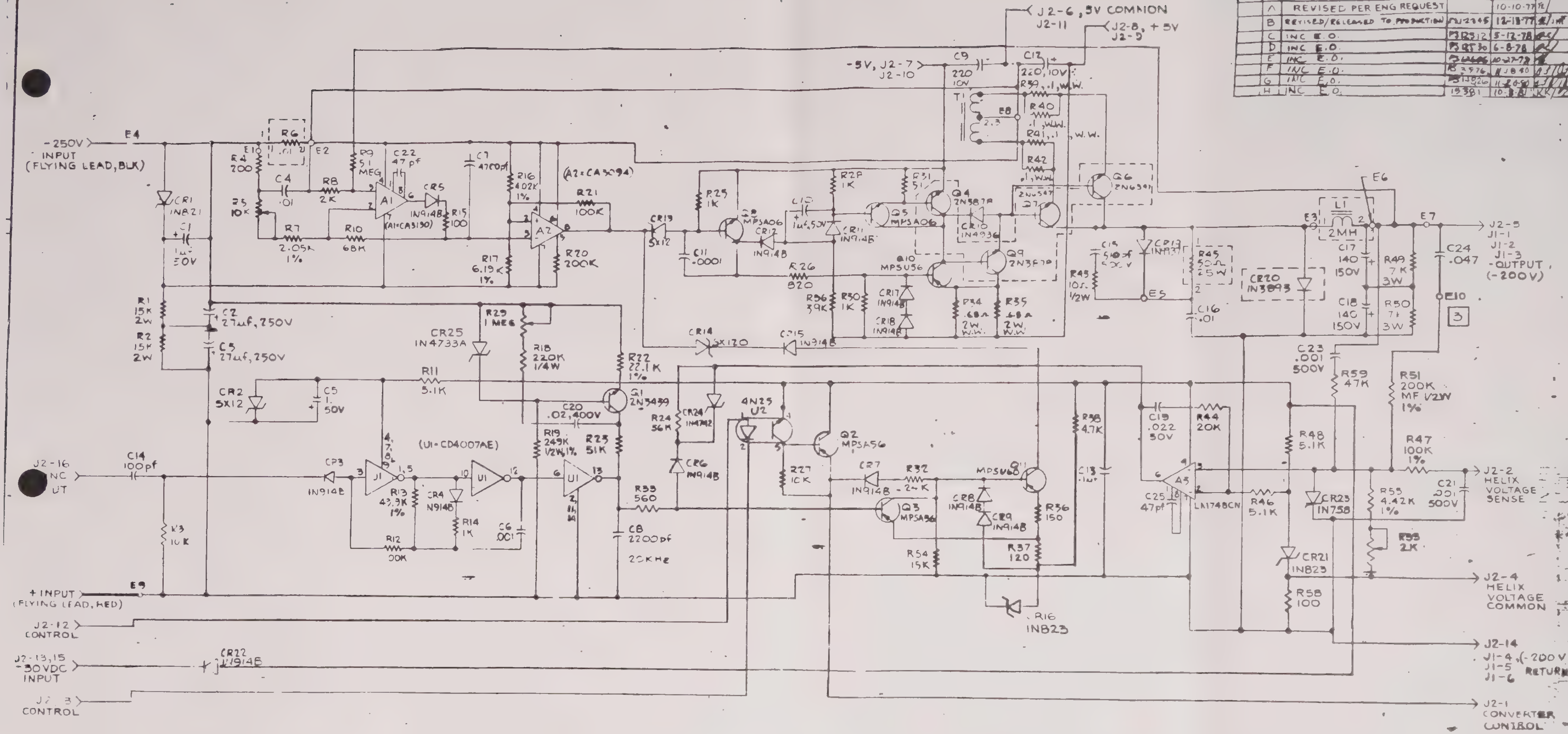
varian	MICROWAVE EQUIPMENT OPERATIONS	OSC/BIAS PCB ASSY.	LM 113483	P

ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO -00	01	-02	-03
104		HEAT SINK	66-807-759	AHAMTOR	370	1			
105		THERMAL COMPOUND	88-298900	WAKEFIELD	120-8	AR			
106		BUSHING	22-419 832	AMATOM	9222-PH-140	2			
107		INSULATOR, TO-3	62-898002	UNION CARBIDE	H-4001	1			
108		INSULATOR, PLASTIC	62-899 937	THERMALLOY	43-77-2	4			
109		WASHER, INTERNAL TOOTH #4	14-302 00[illegible]			1			
110		WIRE, UNINSUL., . #20 COPPER	81-099920			AR			
111		TUBING, INSUL, FIBERGLASS-SILICONE	88-495071			AR			


REVISIONS
ZONE | LTR | DESCRIPTION | EO | DATE | APPROVED
A | ADDED DIM 2 3 SLIDE MTG ADJ. | — | 7-6-77
B | REL FOR MFR | PS12345 | 1-19-78
C | INC. E.C. | PS12461 | 10-27-78
12.22
310.4
19.00
1.48
4.95
376
7.17
10.72
182.12
24.00
609.6
1.63
41.4
6.750
425.45
1.025
26.60
2.13
54.1
TYP
SLIDE MTG ADJUSTMENT
11.75
298.45
AIR EXHAUST
RF-OUT CONNECTOR LOCATION
RF-IN CONNECTOR LOCATION
RF-OUT
RF-IN
FILTERED AIR INTAKE
6.99
177.54
℄ SLIDES ACCURIDE MODEL 771-24
PRIME POWER INPUT TERMINALS
PROJECTION
INCH
MM
NEXT ASSEMBLY
USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± 1 2PL ± .02
3PL ± .015
FRAC ± 1/64
ANG ± 1°
SURFACE FINISH
MATERIAL
SPEC NO
FINISH
QTY | IDENTIFYING NUMBER | DESCRIPTION | CODE IDENT | TEM
LIST OF MATERIALS
CONTRACT NUMBER
DR F. GAMBLE 3-17-77
CHK L. Ando 1/26/78
APPD 1/26/78
APPD 1-26-78
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL
varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA CALIFORNIA
OUTLINE DRAWING
100/200W TWTA
SIZE D
CODE IDENT NO 99313
113850 C
SCALE NONE
SHEET 1 OF 1
SUPERSEDES

REVISIONS

ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	A	REVISED PER ENG REQUEST		10-10-77	
	B	REVISED/RELEASED TO PRODUCTION		12-13-77	
	C	INC E.O.		5-12-78	
	D	INC E.O.		6-8-78	
	E	INC E.O.			
	F	INC E.O.			
	G	INC E.O.			
	H	INC E.O.	19381		



3 CONNECT JUMPER BETWEEN E7 & E10 TO OPERATE WITHOUT HIGH VOLTAGE MODULE.

2. ALL CAPACITORS ARE IN MICROFARADS.

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED:

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER
DR Tillie Evans 4-7-77
CHK
APPD
APPD 1-26-78
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
SANTA CLARA, CA

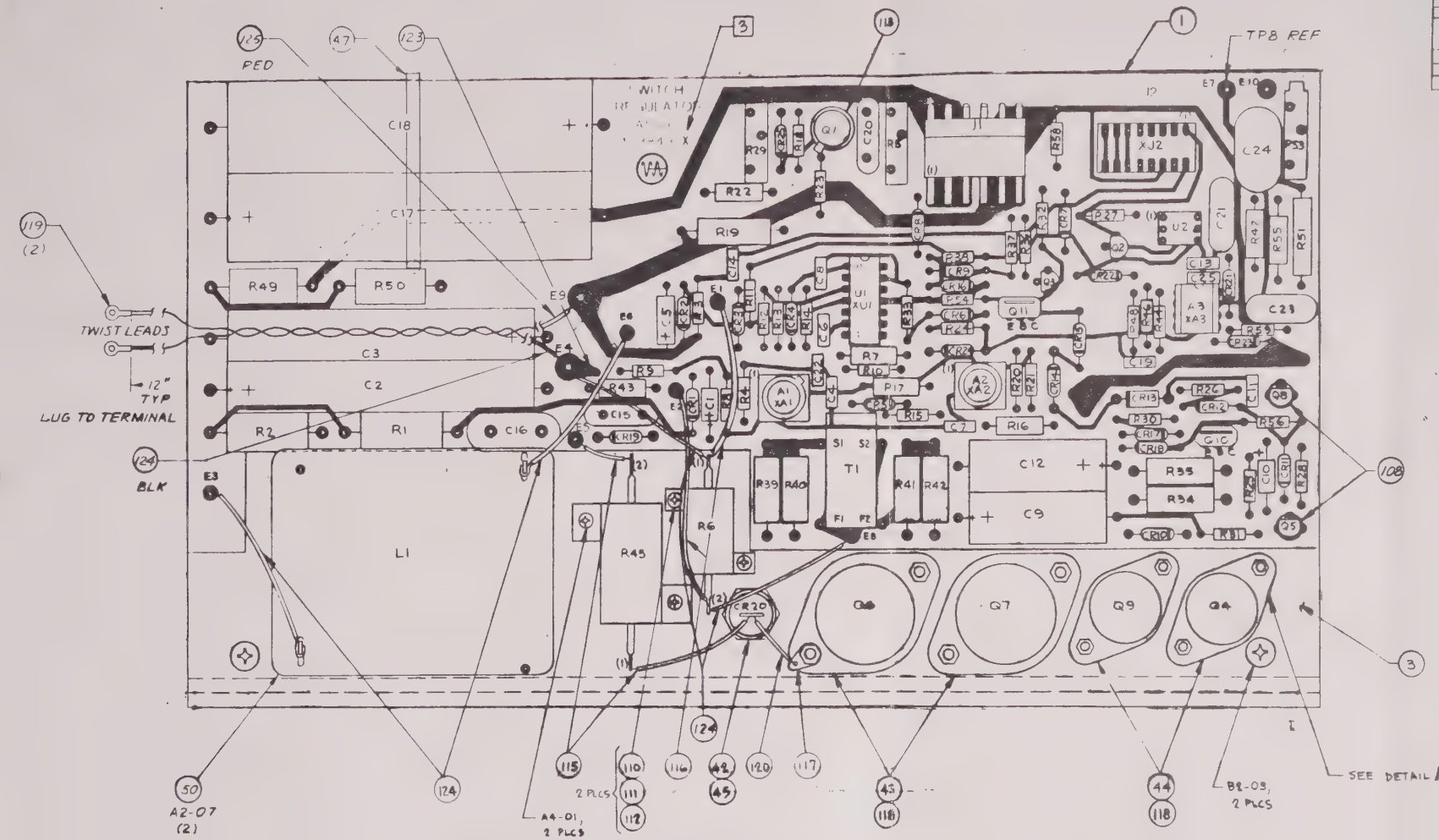
SCHEMATIC, SWITCH REGULATOR PCB

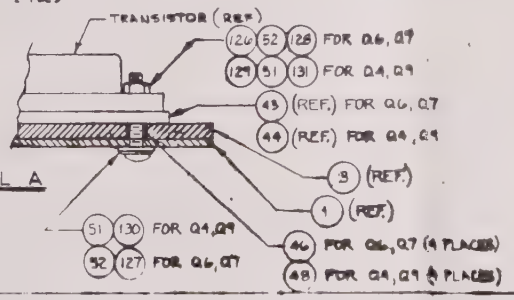
SIZE D | CODE IDENT NO 59782 | 113846 | H

SCALE NONE | SHEET

SUPERSEDES

A	REVISED & RELEASED TO PRODUCTION	PS12345	26/78	
B	REVISED/EO	PS12405	4/7/78	
C	INC E.O.	PS12580	6/12/78	
D	INC E.O.	PS12586	5/23/78	
E	INC E.O.	PS12606	10-27-78	
F	INC E.O.	PS12670	10-27-78	
G	INC E.O.	PS12924	1-27-80	
H	INC E.O.	PS13976	11-11-80	
J	INC E.O.	PS14826	11-20-80	
K	INC E.O.	PS14966	2-27-81	
L	INC E.O.	PS14979	5-12-81	
M	INC E.O.	13092	9-29-81	KK/LA
N	INC E.O.	13381, 13396	10-8-81	KK/LA





DETAIL A

3 MARK WITH CURRENT REVISION LETTER OF ASSY.
2 ASSEMBLE USING HARDWARE/DWG 110625.
1 ASSEMBLE / VARIAN WORKMANSHIP STD 87 800-299
NOTES:

SEE SEPARATE LIST OF MATERIALS - LM 113849

L113979	100/200 W		
NEXT ASSEMBLY	USED ON		
APPLICATION			

DECIMALS ± .005 ANG ± 1° FRAC ± 1/64 SURFACE FINISH
MATERIAL
SPEC NO
FINISH

DR	Tillie Evans	1-12-78
CHK		1-17-78
APPD		1/23/78
APPD		1-26-78

DESIGN ACTIVITY

MATERIALS 12345

varian — MICROWAVE EQUIPMENT OPERATIONS, SANTA CLARA CALIFORNIA

ASSEMBLY, SWITCH REGULATOR PCB

SIZE D — CODE IDENT NO 59782 — 113849 — N

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE: SWITCH REGULATOR PCB ASSY. 13361P	LM 113849	REV. N
CODE IDENT NO 59782	APPROVAL DATE		Prepared by: 12/7/77	Checked by:

APPLICATION		
NEXT ASSEMBLY	USED ON	EO
113979	100/200 W TWTA	

REVISION				
REV	DESCRIPTION	EO	DATE	APPROVED
A	REVISED & RELEASED TO PRODUCTION	PS12347	1/26/78	JHT
B	INC E.O.	PS12485	4/4/78	
C	INC E.O.	PS12530	5/12/78	
D	INC E.O.	PS12586	5/23/78	
E	INC E.O.	PS12606	10/30/78	
F	INC E.O.	PS12870	10/30/78	
G	INC E.O.	PS12924	2-27-79	
H	INC E.O.	PS13976	11-11-80	
J	INC E.O.	PS14826	11-[illegible]-80	
K	INC E.O.	PS14966	2-27-81	
L	INC. E.O.	PS14977	5-12-81	
M	INC E.O.	15032	9-29-81	KK/
N	INC E.O. 15381, 15396		10-8-81	KK/

REVISION STATUS

SHEET																											
LTR																											
SHEET																											
LTR																											
SHEET																											
LTR																											

varian	MICROWAVE EQUIPMENT OPERATIONS	SWITCH REGULATOR PCB ASSY.	LM 1138[illegible]	REV N

ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
1		FAB, SWITCH REGULATOR	D113848-00			1			
2		SCHEMATIC	D113846			REF			
3		HEATSINK	D135879			1			
4									
5	A1	I.C. OP-AMPLIFIER	62-600537	RCA	CA3130S	1			
6	A2	I.C. - AMPLIFIER	62-601012	RCA	CA3094E	1			
7	A3	I.C. - AMPLIFIER	62-601013	NATIONAL SEMICONDUCTOR	LM748CN	1			
8	C1,5,10	CAPACITOR, TANT., 1µF, 50V	41-606802	SPRAGUE	CS13BG105K	3			
9	C2,3	CAPACITOR, ELECT., 27µF, 250V	41-506106	SPRAGUE	600D276F250DX4	2			
10	C4	CAPACITOR, CERAMIC, .01µF, 200V	41-229951	ANY	CK06BX103K	1			
11	C7	CAPACITOR, CERAMIC, 4700 pF, 100V	41-229955		CK05BX472K	1			
12	C6	CAPACITOR, MICA, .001µF 200V	41-229953	ANY	CK05BX102K	1			
13	C8	CAPACITOR, CERAMIC, .0022µF, 100V	41-205921	ERIE	8131-100C0G0222J	1			
14	C9,12	CAPACITOR, ELECT., 220µF, 10V	41-506501	SPRAGUE	600D227G010DE4	2			
15	C11,14	CAPACITOR, CERAMIC, .0001µF, 200V	41-229960	ANY	CK05BX101K	2			
16	C13	CAPACITOR, CERAMIC, .1µF, 100V	41-229952	ANY	CK06BX104K	1			
17	C19	CAPACITOR, CERAMIC, .022µF, 100V	41-229961	ANY	CK06BX223K	1			
18	C15	CAPACITOR, MICA, 510 pF, 500V	41-159952	ANY	CM06FD11J03	1			
19	C16	CAPACITOR, MICA, .01µF, 500V	41-159994	ANY	CM07FD103J03	1			
20	C17,18	CAPACITOR, ELECT., 140µF, 150V	41-516705	SPRAGUE	601D147F150GS4	2			
21	C20	CAPACITOR, CERAMIC, .02µF, 400V	41-269515	ERIE	84100Z5U0203M	1			

varian	MICROWAVE EQUIPMENT OPERATIONS	SWITCH REGULATOR PCB ASSY.	LM 113849	REV N

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
22	C21,23	CAPACITOR, MICA, .001µF, 500V	41-159959	ANY	CM06FD102J03	2			
23	C22 ,25	CAPACITOR, CERAMIC 47 pF,100V,10%	41-229509	VARADYNE	2115COG100R470K	2			
24	C24	CAPACITOR, MICA, .047µF, 600V	41-765001	CORNELL DUBELIER	DMF6S47	1			
25									
26	CR1	DIODE, ZENER, 6.2V	66-300821		1N821	1			
27	CR2,13	DIODE, ZENER, 12V	66-393298	SEMTECH	SX12	2			
28	CR3-9,11 12,15,17 18,22	DIODE, SIGNAL	66-320914		1N914B	13			
29	CR10	DIODE, RECTIFIER	66-304936		1N4936	1			
30	CR23	DIODE	66-300758		1N758	1			
31	CR14	DIODE, BREAKDOWN, 120V	66-393299	SEMTECH	SX120	1			
32	CR16,21	DIODE, ZENER	66-300823		1N823	2			
33	CR19	DIODE	66-304937		1N4937	1			
34	CR20	DIODE, RECTIFIER	66-303893		1N3893	1			
35	CR24	DIODE	66-304742		1N4742	1			
36									
37	CR25	DIODE	66-314733		1N4733A	1			
38									
39									
40	J1	CONN., 6 PIN	51-407151	MOLEX	09-75-1071	1			
41	XJ2	CONN., SOCKET, 16 PIN	54-634023	CIRCUIT ASSEMBLY	CA-165-105D	1			

varian	MICROWAVE EQUIPMENT OPERATIONS	SWITCH REGULATOR PCB ASSY.	LM 11384	REV N

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
42		INSULATOR, DO-4	62-898000	UNION CARBIDE	H-4027	1			
43		INSULATOR, TO-3	62-898002	UNION CARBIDE	H-4001	2			
44		INSULATOR, TO-66	62-899881	INDUSTRIAL MICA	14427	2			
45		WASHER NYLON	14-998068	SEASTROM	5610-96-110	1			
46		BUSHING	22-420029	AMATOM	9223-N-140	4			
47		CABLE TIE	22-119654	PANDUIT	SST3S	1			
48		BUSHING	22-419540	DELBERT BLINN	TW-140-180-170T	4			
49	T1	INDUCTOR	C110447			1			
50	L1	INDUCTOR	C110584-00			1			
51		WASHER, INTERNAL TOOTH #4	14-302004			4			
52		WASHER INTERNAL TOOTH #6	14-302006			4			
53	Q1	TRANSISTOR, NPN	62-903439		2N3439	1			
54	Q2,3	TRANSISTOR, PNP	62-920019	MOTOROLA	MPSA56	2			
55	Q4,9	TRANSISTOR, NPN	62-903878		2N3878	2			
56	Q5,8	TRANSISTOR, NPN	62-920018	MOTOROLA	MPSA06	2			
57	Q6,7	TRANSISTOR, NPN	62-906547	MOTOROLA	2N6547	2			
58	Q10	TRANSISTOR, PNP	62-920016	MOTOROLA	MPSU56	1			
59	Q11	TRANSISTOR, PNP	62-920020	MOTOROLA	MPSU60	1			
60	R11,48	RESISTOR, COMP., 5.1K, 1/4W, 5%	32-301451		RC07GF512J	2			
61	R1,2	RESISTOR, COMP., 15K, 2W, 5%	34-401515		RC42GF153J	2			
62	R3,21	RESISTOR, COMP., 10K, 1/4W, 5%	32-301510		RC07GF103J	2			

varian | MICROWAVE EQUIPMENT OPERATIONS | SWITCH REGULATOR PCB ASSY. | LM 113849 | REV N

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
63	R4	RESISTOR, COMP., 200 OHM, 1/4W,5%	32-301320		RC07GF201J	1			
64	R5	RESISTOR, VAR., 10K, 3/4W, 10%	36-792215	BOURNS	3006P-1-103	1			
65	R6	RESISTOR, W.W., .01 OHM, 10W, 5%	35-375222	DALE	RH-10 TYPE	1			
66	R7	RESISTOR, M.F., 2.05K, 1/8W, 1%	31-610277		RN55C	1			
67	R8	RESISTOR, COMP., 2K, 1/4W, 5%	32-301420		RC07GF202J	1			
68	R9	RESISTOR, COMP., 5.1 MEG, 1/4W,5%	32-301751		RC07GF515J	1			
69	R12,21	RESISTOR, COMP., 100K, 1/4W, 5%	32-301610		RC07GF104J	2			
70	R10	RESISTOR, COMP., 68K, 1/4W, 5%	32-301568		RC07GF683J	1			
71	R13	RESISTOR, M.F., 49.9K, 1/8W, 1%	31-610278		RN55C4992F	1			
72	R38	RESISTOR, COMP., 4.7K, 1/4W, 5%	32-301447		RC07GF472J	1			
73	R15,58	RESISTOR, COMP., 100 OHM, 1/4W,5%	32-301310		RC07GF101J	2			
74	R16	RESISTOR, M.F., 4.02K, 1/4W, 1%	31-604402		RN60	1			
75	R17	RESISTOR, M.F., 6.19 K, 1/4W, 1%	31-604619		RN60	1			
76	R18	RESISTOR, COMP., 220K, 1/4W, 5%	32-301622		RC07GF224J	1			
77	R19	RESISTOR, M.F., 249K, 1/2W, 1%	31-614819	DALE	MFF-1/4-T2	1			
78	R20	RESISTOR, COMP., 200K, 1/4W, 5%	32-301620		RC07GF204J	1			
79	R22	RESISTOR, M.F., 22.1K, 1/4W, 1%	31-225221		RN60	1			
80	R23	RESISTOR, COMP., 51K, 1/4W, 5%	32-301551		RC07GF513J	1			
81	R14,25 28,30	RESISTOR, COMP., 1K, 1/4W, 5%	32-301410		RC07GF102J	4			
82	R26	RESISTOR, COMP., 820 OHM, 1/4W,5%	32-301382		RC07GF821J	1			
83	R53	RESISTOR, VAR., 2K, 3/4W, 10%	36-792211	BOURNS	3006P-1-202	1			

varian | MICROWAVE EQUIPMENT OPERATIONS | SWITCH REGULATOR PCB ASSY. | LM 113849 | REV N

ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
84	R31	RESISTOR, COMP., 51 OHM, 1/4W, 5%	32-301251		RC07GF510J	1			
85	R32	RESISTOR, COMP., 24K, 1/4W, 5%	32-301524		RC07GF243J	1			
86	R33	RESISTOR, COMP., 560 OHM, 1/4W,5%	32-301356		RC07GF561J	1			
87	R34,35	RESISTOR, W.W., .68 OHM, 2W, 5%	35-199120	IRC	BWH TYPE	2			
88	R36	RESISTOR, COMP., 150 OHM, 1/4W,5%	32-301315		RC07GF151J	1			
89	R37	RESISTOR, COMP., 120 OHM, 1/4W,5%	32-301312		RC07GF121J	1			
90	R39-42	RESISTOR, W.W., .1 OHM, 2W, 10%	35-199130	IRC	BWH TYPE	4			
91	R43	RESISTOR, COMP., 10 OHM, 1/2W, 5%	32-201210		RC20GF100J	1			
92	R44	RESISTOR, COMP., 20 K, 1/4W, 5%	32-301520		RC07GF203J	1			
93	R45	RESISTOR, W.W., 50 OHM, 25W, 1%	31-588250	DALE	RH25 TYPE	1			
94	R46	RESISTOR, COMP., 5.1K, 1/4W, 5%	32-301451		RC07GF512J	1			
95	R24	RESISTOR, COMP., 56K, 1/4W, 5%	32-301556		RC07GF563J	1			
96	R47	RESISTOR, COMP., 100K, 1/4W, 1%	31-226100		RN60	1			
97	R51	RESISTOR, M.F., 200K, 1/2W, 1%	31-614804	DALE	MFF-1/4-T2 TYPE	1			
98	R29	RESISTOR, VAR., 1 MEG	36-792314	BOURNS	3006P-1-105	1			
99	R55	RESISTOR, M.F., 6.19K, 1/4W, 1%	31-604619		RN60	1			
100	R49,50	RESISTOR, W.W., 7K, 3W, 5%	31-596 003	DALE	CW-2B TYPE	2			
101	R56	RESISTOR, COMP., 3.9K, 1/4W, 5%	32-301439		RC07GF392J	1			
102									
103	R54	RESISTOR, COMP., 15K, 1/4W, 5%	32-301515		RC07GF153J	1			
104	R59	RESISTOR, COMP., 47K, 1/4W, 5%	32-301547		RC07GF473J	1			

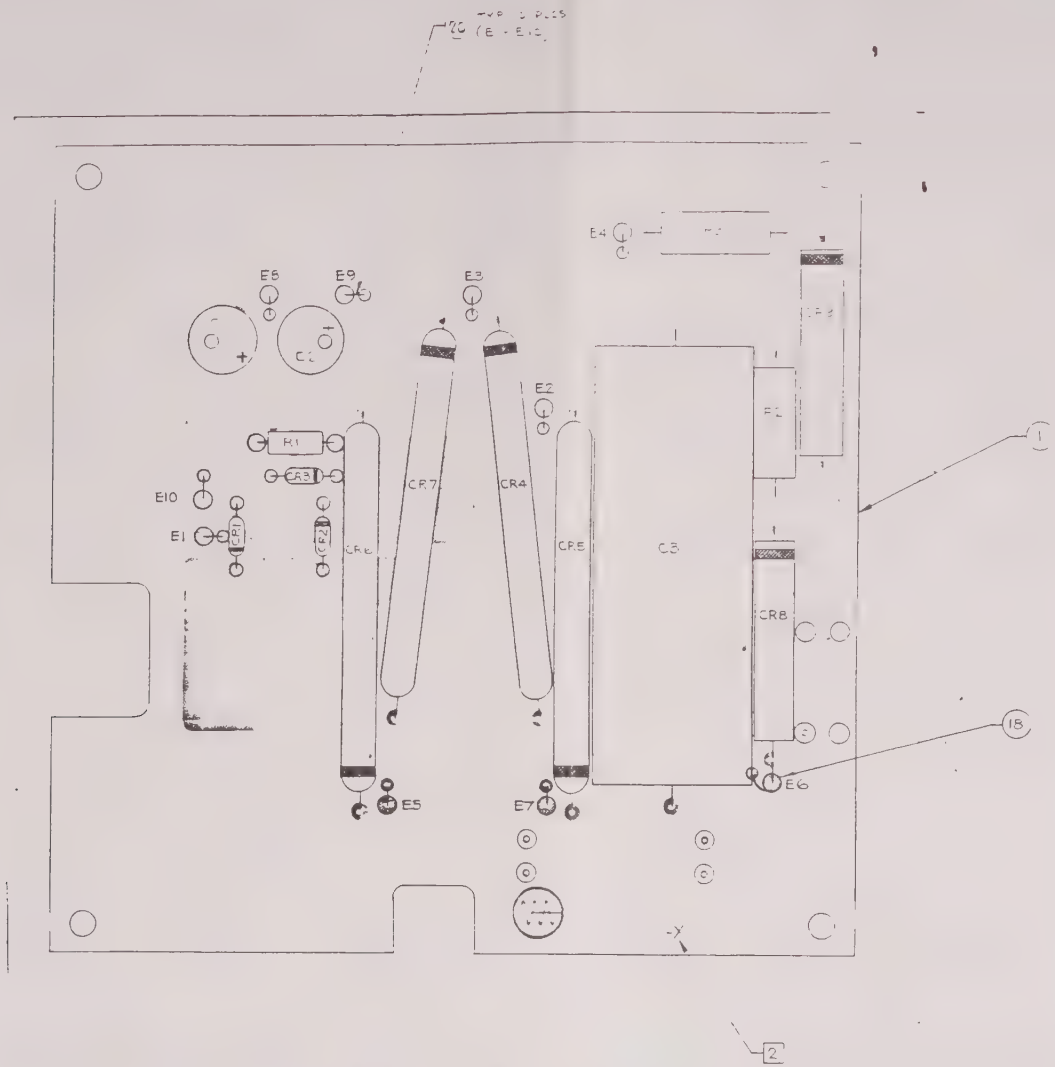
varian | MICROWAVE EQUIPMENT OPERATIONS | SWITCH REGULATOR PCB ASSY. | LM 113849 | REV N

ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
105	U1	I.C.-TRANSISTOR ARRAY	62-600027	RCA	CD4007AE	1			
106	U2	I.C.-PHOTOTRANSISTOR	66-599720		4N25	1			
107									
108		PAD, MTG. (Q5 & Q8)	62-899958			2			
109	XU1	SOCKET, I.C.	54-634007	SAE	CSA3100-14B	1			
110		SCREW, 2-56 x 3/16	12-221102-03			2			
111		WASHER, FLAT, #2	14-112002			2			
112		LOCKWASHER, INTERNAL #2	14-307102			2			
113	XQ1	MOUNTING PAD-SEMICONDUCTOR	62-899958			1			
114									
115		WIRE, EE, TEF, INSUL., 20AWG, WHT	81-288834			AR			
116		WIRE, EE, TEF, INSUL., 24AWG, GRN	81-288755			AR			
117		SOLDER LUG #6	16-139903	SHAKEPROOF	#2102-06-00	1			
118		THERMAL COMPOUND	88-298900	WAKEFIELD	120-8	AR			
119		TERMINAL, RING, #10, BLU	15-604112			2			
120		WIRE, EE, TEF, INSUL., 20AWG, BLU	81-288831			AR			
121	XU2	SOCKET, 6 PIN	54-910329	ROBINSON-NUGENT	ICN-063-S3-6	1			
122	XA1, XA2 XA3	SOCKET, 8 PIN	54-634050	AUGAT	508-AG11D	3			
123		WIRE, BARE-BUS #22 AWG	81-099922			A/R			
124		WIRE, EE, TEF. INSUL., 16 AWG, BLK	81-249980			AR			
125		WIRE, EE, TEF. INSUL., 16 AWG, RED	81-249982			AR			

varian	MICROWAVE EQUIPMENT OPERATIONS	SWITCH REGULATOR PCB ASSY.	LM 113849	REV N

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO -00	-01	-02	-03
126		SCREW, PANHEAD #6-32 x 3/4	12-222006-12			4			
127		WASHER, PLAIN #6	14-122006			4			
128		NUT, HEX #6	13-102006			4			
129		SCREW, PANHEAD #4-40 x 5/8	12-222004-10			4			
130		WASHER, PLAIN #4	14-122004			4			
131		NUT, HEX #4	13-102004			4			

REVISIONS				
	DESCRIPTION	EC	DATE	APPROVED
A	[illegible]	PS 12345	1-19-78	[illegible]
B	INC EC	PS 13595	5-12-81	[illegible]
C	INC EC	15499	1-30-8	[illegible]



SEE SEPARATE LIST OF MATERIALS - [illegible]

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS		

3 RAISE DIODES CR4, CR5, CR6, CR7 1/8-1/4 ABOVE PCB

2 MARK WITH CURRENT REVISION LETTER OF ASSEMBLY

1 ASSEMBLE PER VARIAN WORKMANSHIP STD 87-800-192

NOTES:

D113919	D113919
NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSION ARE IN INCHES

DECIMALS 1PL ± .1 2PL ± .05

3PL ± .005 FRAC ± 1/64

ANG ± 1° SURFACE FINISH ✓

MATERIAL

SPEC NO

FINISH

CONTRACT NUMBER

DR [illegible] 1-19-78

CHK [illegible] 1/24/78

APPD [illegible] 1/24/78

APPD [illegible] 1-26-78

DESIGN ACTIVITY APPROVAL

CUSTOMER APPROVAL

varian — MICROWAVE EQUIPMENT OPERATIONS SANTA CLARA, CALIFORNIA

ASSEMBLY HIGH VOLTAGE PCB 2

SIZE D CODE IDENT NO 59782 113902

SCALE 2/1

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE: HIGH VOLTAGE PCB #2	LM 113902	REV C
CODE IDENT NO 59782	APPROVAL	DATE 12-[illegible]	1-2-78	0328H

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
D1.3[illegible]	D[illegible]919		A	REVISED & RELEASED TO PRODUCTION	PS12345	1/19/78	TL/[illegible]
			B	INC. E.O.	PS13595	5-12-81	NA/[illegible]
			C	INC E.O.	15499	11/30/81	JS/ KK

REVISION STATUS

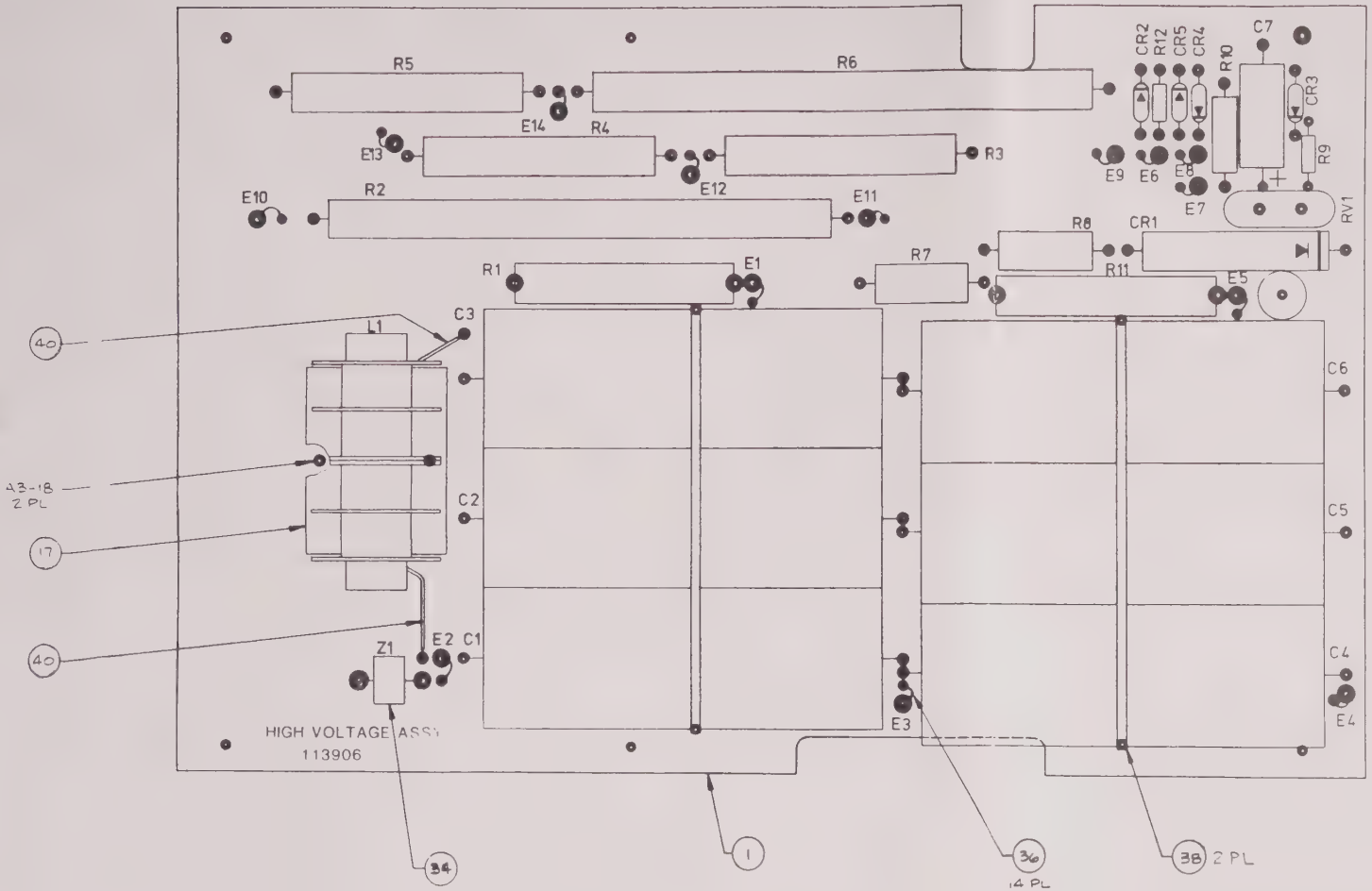
SHEET																											
LTR																											
SHEET																											
LTR																											
SHEET																											
LTR																											

FORM 1758 01 375

varian	MICROWAVE EQUIPMENT OPERATIONS	HIGH VOLTAGE PCB #2	LM 113902	REV C

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. 00	01	-02	-03
1		FABRICATION	C113901			1			
2		SCHEMATIC	D113907			REF			
3									
4									
5	C1,2	CAPACITOR, ELECT., 680 uf	41-507009	SPRAGUE	672D687H6R3DM5C	2			
6	C3	CAPACITOR,MYLAR, .1μf,8000VDC 20%	41-719307	TRW	X675HV104080W2	1			
7									
8									
9	CR1,2	DIODE	66-306079		1N6078	2			
10	CR3	DIODE	66-304958		1N4958	1			
11	CR4-7	DIODE	66-393324	SEMTECH	SCF7500	4			
12	CR8,9	DIODE	66-300033	H.V.D.	CX513	2			
13									
14									
15	R1	RESISTOR, 1K, 1/2W	32-202410		RC20GF102K	1			
16	R2,3	RESISTOR, C.C., 100Ω, 2W, 5%	34-401310		RC42GF101J	2			
17									
18	E1-E10	TERMINAL	16-229946	USECO	2011B-1	10			
19									
20		WIRE, BARE - BUS #22 AWG	31-011022			A/R			
21									

REVISIONS					
ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	L	REVISED & REDRAWN	33[illegible]	12-16-81	[illegible]
	C	INI. EO	[illegible]	[illegible]	[illegible]



SEE SEPARATE L/M 113906

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

NOTES

1. ASSEMBLE USING HARDWARE DWG 110625.
2. ASSEMBLE PER VARIAN WORKMANSHIP STD 87-800-192.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± 1 2PL ± 02
3PL ± 005 FRAC ± 1 64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER
DIP
HP
APPD
APPD
2-16-81
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

D113919	D113919
NEXT ASSEMBLY	USED ON
APPLICATION	

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA CALIFORNIA

ASSEMBLY
HIGH VOLTAGE PCB #1

SIZE	CODE IDENT NO		
D	[illegible]	113906	E

SCALE 2/1 SHEET 1 OF 1

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE: HIGH VOLTAGE PCB #1	LM 113906	REV E
CODE IDENT NO 51182	APPROVAL	DATE	C535A	

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
113919	113313		A	REVISED/RELEASED FOR PRODUCTION	PS12345	1/18/78	TE/
113919			B	INC EO ADD-ON	PS14748	9/22/80	
			C	INC. E.O.	15172, 15350	9/30/81	KK/
			D	INC. EO.	15513, 15516	12/14/81	JS/
			E	INC E.O.	15993	5-4-82	JS/

REVISION STATUS

SHEET																										
LTR																										
SHEET																										
LTR																										
SHEET																										
LTR																										

FORM 1758 01 375

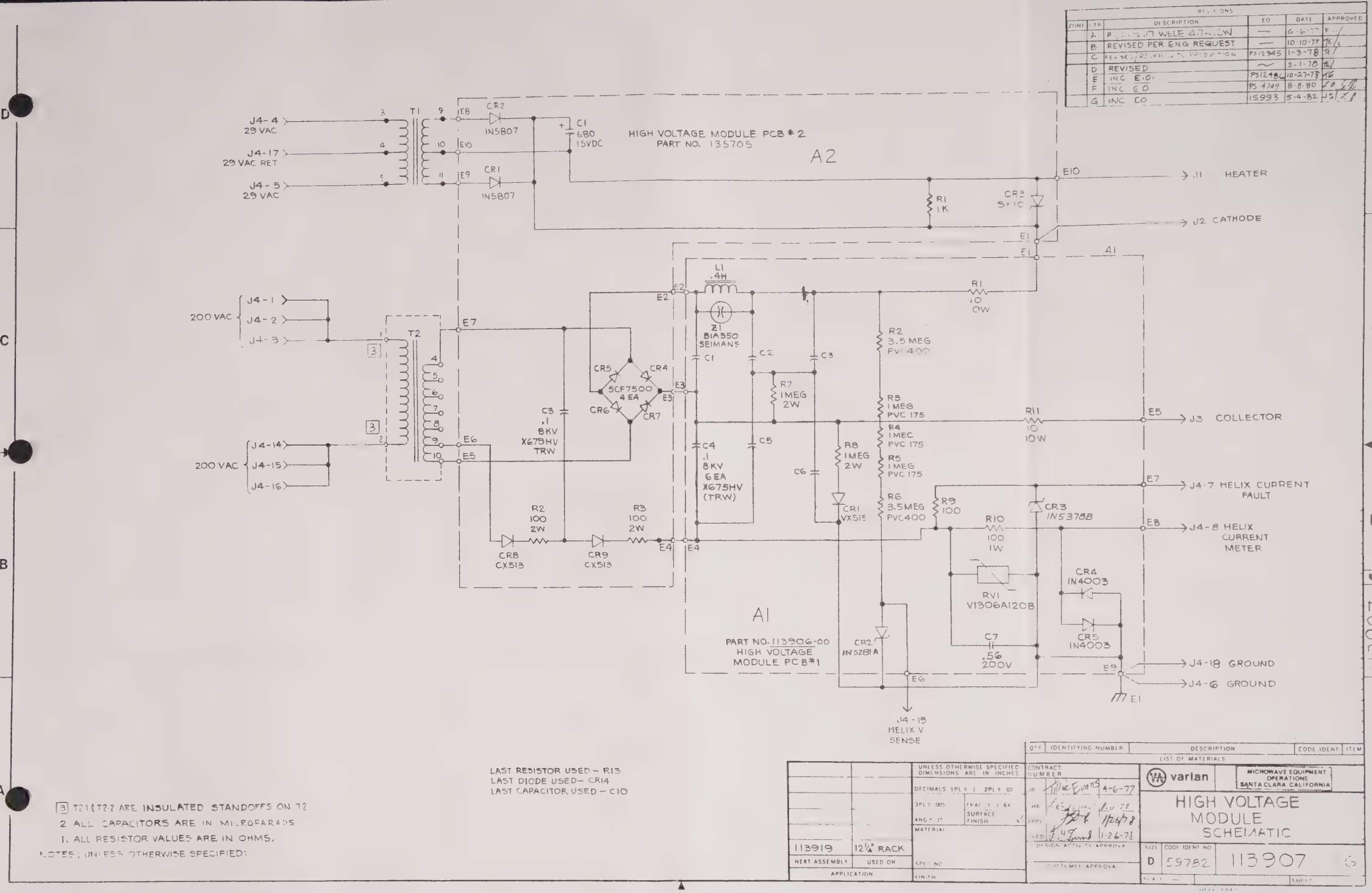
MICROFILM

varian	MICROWAVE EQUIPMENT OPERATIONS	HIGH VOLTAGE PCB #1	LM 113906	REV E

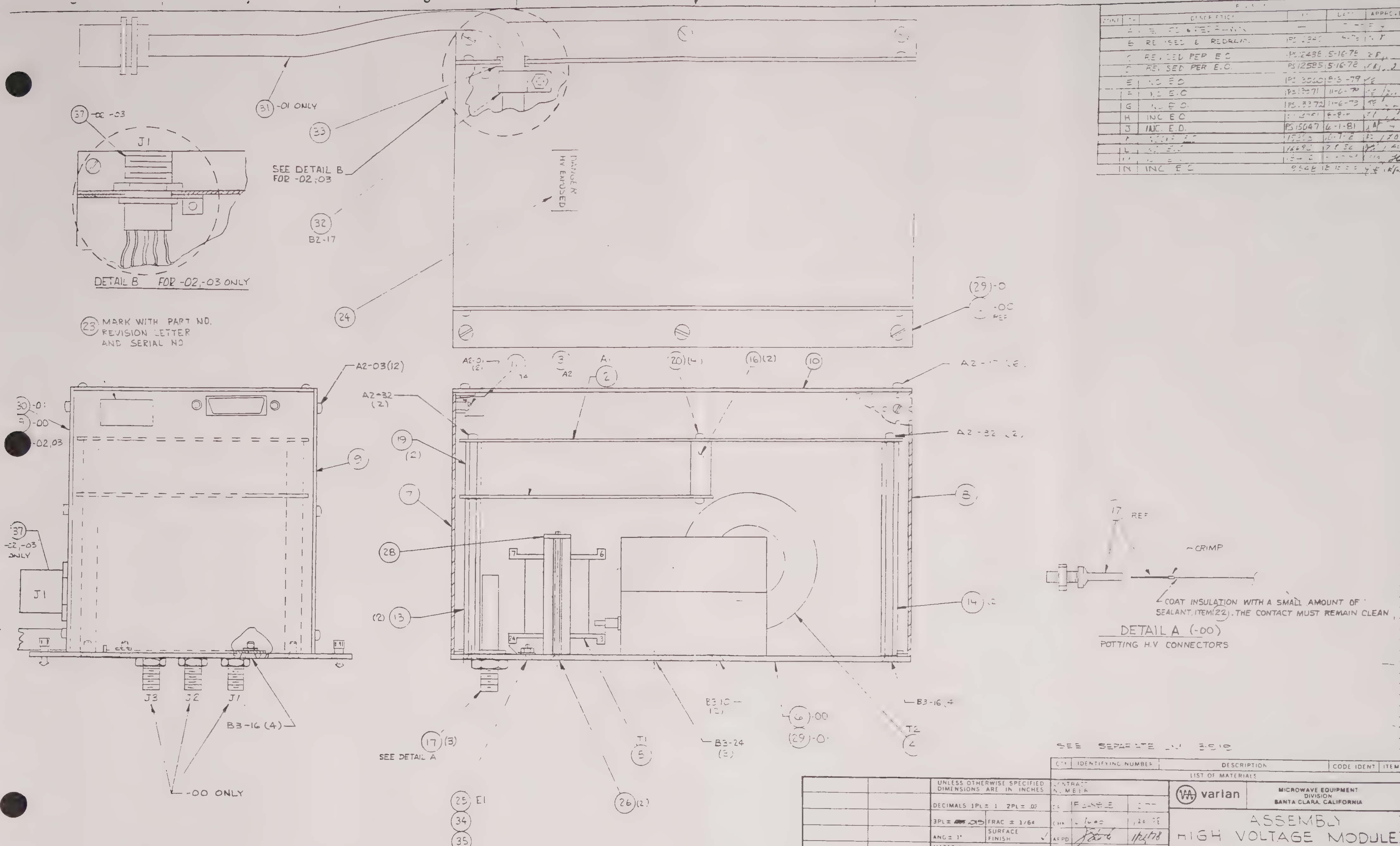
ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
1		FABRICATION	113905			1	1		
2		SCHEMATIC	113907			REF	–		
3		SCHEMATIC	135758			–	REF		
4	C1-C6	CAP., ELECT., .1 uf, 8KV	41-719307	TRW	X675HV104080W2	6	6		
5	C7	CAP., .56 uf, 200V	41-724980	ELECTRO-CUBE	230B1C564K	1	1		
6									
7									
8	CR1	DIODE	66-300052	H.V.D.	VXS15	1	1		
9	CR2	DIODE, ZENER, 200V, ½W	66-315281	MOTOROLA	1N5281A	1	1		
10	CR3	DIODE	66-325378	SEMTECH	1N5378B	1	1		
11	CR4,5	DIODE	66-304003		1N4003	2	2		
12									
13									
14									
15									
16									
17	L1	INDUCTOR, H.V., 320 mH	113993			1	1	1	
18									
19									
20									
21									

varian	MICROWAVE EQUIPMENT OPERATIONS	HIGH VOLTAGE PCB #1	LM 113906	REV E

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
22	R1,11	RESISTOR, W.W., 10 OHM, 10W	35-388-210	OHMITE	1710	2	2		
23	R2,6	RESISTOR, THK FILM - 3.5 MEG 1%	31-600653	PYROFILM	PVC400	2	2		
24	R3-5	RESISTOR, THK FILM - 1 MEG 1%	31-600652	PYROFILM	PVC175	3	3		
25	R7,8	RESISTOR, C.C., 1M OHM 2W, 10%	34-402710		RC42GF105K	2	2		
26	R9	RESISTOR, C.C., 100 OHM 1/4W 5%	32-301310		RC07GF101J	1	1		
27	R10	RESISTOR, C.C. 100 OHM 1W 5%	33-301310		RC32GF101J	1	1		
28	R12	RESISTOR, C.F., 3.6 OHM, 1/4W, 5%	32-301136			-	1		
29									
30									
31	RV1	VARISTOR	55-400001	G.E.	V130LA20A	1	1		
32									
33									
34	Z1	SPARK GAP PROTECTOR	55-500160	SIEMENS	B1A350	1	1		
35									
36		WIRE, BUS, BARE #22 AWG	81-099922			AR	AR		
37									
38		CORD, LACING	88-599930			AR	AR		
39									
40		SLEEVING, INSULATING #22	88-494803	BENTLEY-HARRIS	BH1151-HB1	A/R	AR		
41									
42									



REVISIONS
ZONE | LTR | DESCRIPTION | EO | DATE | APPROVED
A | P... WELE 4.7-...2W | — | 6-6-77
B | REVISED PER ENG REQUEST | — | 10-10-77
C | REVISED/RELEASED TO PRODUCTION | PS12345 | 1-3-78
D | REVISED | ~ | 2-1-78
E | INC E.O. | PS12486 | 10-27-78
F | INC E.O. | PS14749 | 8-8-80
G | INC E.O. | 15993 | 5-4-82
J4-4 29 VAC
J4-17 29 VAC RET
J4-5 29 VAC
T1
CR2 1N5807
CR1 1N5807
C1 680 15VDC
HIGH VOLTAGE MODULE PCB #2
PART NO. 135705
A2
E10
J1 HEATER
R1 1K
CR3 SX10
J2 CATHODE
E1
A1
200 VAC
J4-1
J4-2
J4-3
T2
J4-14
J4-15
J4-16
E7
E6
E5
L1 .4H
Z1 BIA350 SEIMANS
C1
C2
C3
R1 10 0W
R2 3.5 MEG PVC400
R7 1MEG 2W
R3 1MEG PVC 175
R4 1MEC PVC 175
R5 1MEG PVC 175
R6 3.5MEG PVC400
R11 10 10W
J3 COLLECTOR
C3 .1 8KV X675HV TRW
CR5
CR4
5CF7500 4 EA
CR6
CR7
C4 .1 8KV 6EA X675HV (TRW)
C5
C6
R8 1MEG 2W
CR1 VX515
R9 100
R10 100 1W
CR3 1N5378B
J4-7 HELIX CURRENT FAULT
J4-8 HELIX CURRENT METER
R2 100 2W
R3 100 2W
CR8 CX513
CR9 CX513
RV1 V1306A120B
CR4 1N4003
CR5 1N4003
C7 .56 200V
CR2 1N5281A
A1
PART NO. 113906-00
HIGH VOLTAGE MODULE PCB #1
J4-18 GROUND
J4-6 GROUND
J4-19 HELIX V SENSE
LAST RESISTOR USED – R13
LAST DIODE USED – CR14
LAST CAPACITOR USED – C10
3 T2-1 & T2-2 ARE INSULATED STANDOFFS ON T2
2 ALL CAPACITORS ARE IN MICROFARADS
1. ALL RESISTOR VALUES ARE IN OHMS.
NOTES: UNLESS OTHERWISE SPECIFIED:
QTY | IDENTIFYING NUMBER | DESCRIPTION | CODE IDENT | ITEM
LIST OF MATERIALS
113919 | 12¼" RACK
NEXT ASSEMBLY | USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005
FRAC ± 1/64
SURFACE FINISH
ANG ± 1°
MATERIAL
SPEC NO
FINISH
CONTRACT NUMBER
Tillie Evans 4-6-77
1/26/78
1-26-78
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL
varian
MICROWAVE EQUIPMENT OPERATIONS SANTA CLARA CALIFORNIA
HIGH VOLTAGE MODULE SCHEMATIC
SIZE D
CODE IDENT NO 59782
113907
G



ZONE	LTR	DESCRIPTION	[illegible]	DATE	APPROVED
	A	[illegible]	—	[illegible]	
	B	REVISED & REDRAWN	PS [illegible]	[illegible]	
	C	REVISED PER E.C	PS 12438	5-16-75	
	D	REVISED PER E.C.	PS 12585	5-16-72	
	E	INC E.C	PS 3060	8-3-79	
	F	INC E.C	PS [illegible]71	11-6-70	
	G	INC E.C.	PS 3372	11-6-73	
	H	INC E.C	[illegible]	[illegible]	
	J	INC. E.D.	PS 15047	6-1-81	
	K	[illegible]	1525[illegible]	[illegible]	
	L	INC E.C	16692	[illegible]	
	M	INC E.C	[illegible]	[illegible]	
	N	INC E.C	9568	[illegible]	

SEE SEPARATE L/M [illegible]

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

NOTES

1. ASSEMBLE USING HARDWARE DWG. 110625.

E113979	.00/200w TWTA
NEXT ASSEMBLY	USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .015 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER
DR F. [illegible]
CHK [illegible]
APPD [signature] 11/26/78
APPD [signature] 11-26-76
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

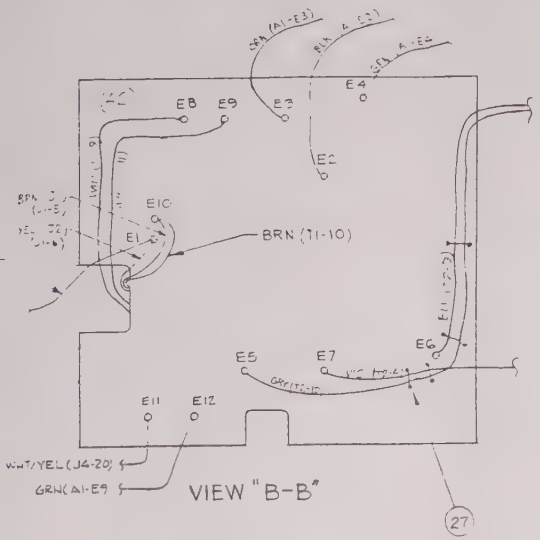
varian MICROWAVE EQUIPMENT DIVISION SANTA CLARA, CALIFORNIA

ASSEMBLY HIGH VOLTAGE MODULE

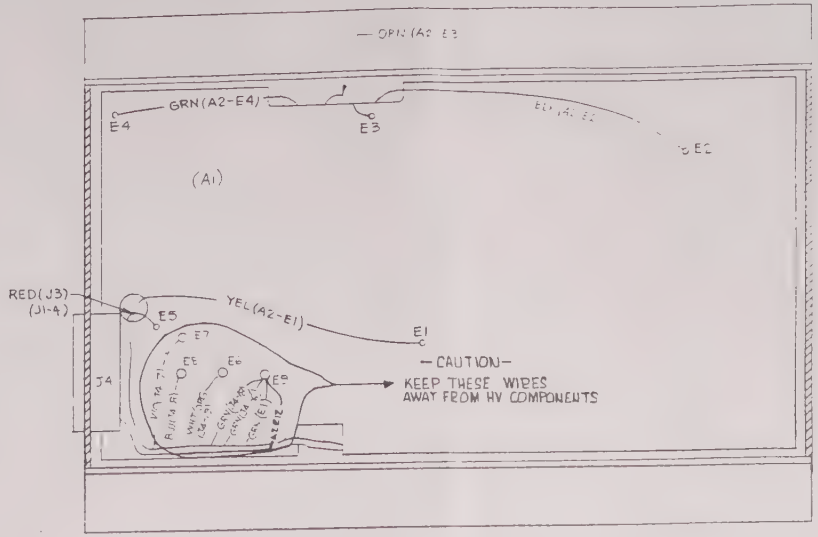
SIZE	CODE IDENT NO		
D	59782	113919	N

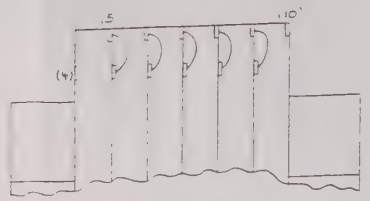
SCALE NONE SHEET 1 OF 2

REVISION			
ZONE	DESCRIPTION	EC	DATE	APPROVED

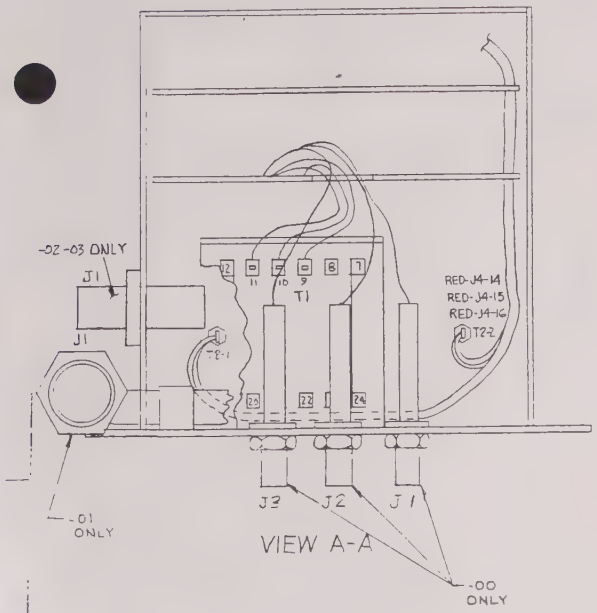


VIEW "B-B"

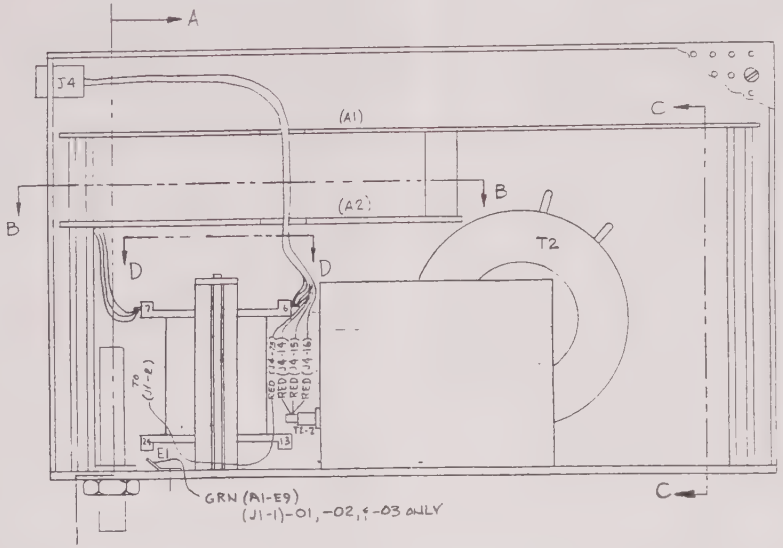


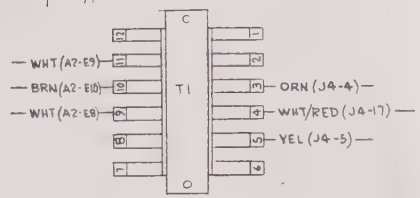


VIEW C-C



VIEW A-A





VIEW D-D

WIRE & CONNECTIONS NOT INCLUDED IN WIRING HARNESS

DASH NO.	NO.	FROM	TO	WIRE TYPE	WIRE PART NO.	AWG	COLOR	LENGTH
-00-01-02-03	1	A1E1	A2E1	HV	81-259754	20	YEL	1'
-00-01-02-03	2	A1E2	A2E2	HV	81-259750	20	BLK	1'
-00-01-02-03	3	A1E3	A2E3	HV	81-259753	20	ORN	1'
-00-01-02-03	4	A1E4	A2E4	HV	81-259755	20	GRN	1'
-00	5	A1E5	J3	HV	81-259752	20	RED	1'
-00	6	A2E1	J2	HV	81-259754	20	YEL	1'
22 -00-01-02-03	7	A2E5	T2-10	HV	81-259758	20	GRY	1'
22 -00-01-02-03	8	A2E6	T2-9	HV	81-259756	20	BLU	1'
-00-01-02-03	9	A2E7	T2-4	HV	81-259757	20	VIO	1'
-00-01-02-03	10	A2E8	T1-5	HV	81-259759	20	WHT	1'
-00-01-02-03	11	A2E9	T1-L	HV	81-259759	20	WHT	1'
-00	12	A2E10	J1	HV	81-259751	20	BRN	1'
-00-01-02-03	3	A1E1C	T1-5	HV	81-259751	20	BRN	
-01-02-03	17		E1	SELF LEADS FROM J1			GRN	
-01-02-03	7	J1-2	J4-5				RED	
-01-02-03	18	J1-4	A1E5				RED	
-01-02-03	19	J1-5	A2E1C				BRN	
-01-02-03	20	J1-6	A2E1				YEL	
-02-03	2	J1-3	E1				BLK	
-03	23	J4-23	A2E11	SELF LEADS			WHT/YEL	
-03	24	A2E12	A1E9	SELF LEADS			ORN	

22 THESE CONNECTIONS MAY BE CHANGED BY TECHNICIAN.

21. LEGEND: BLK(J4-1) = WIRE COLOR(DESTINATION).

NOTES:

SEE SEPARATE LM 113919

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

E113979	100/200W TINTA	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	CONTRACT NUMBER
NEXT ASSEMBLY	USED ON	DECIMALS 1PL ± 1 2PL ± 02	DR P. ROSCO 4-4-78
APPLICATION		3PL ± .005 FRAC ± 1/64	CHK
		ANG ± 1° SURFACE FINISH	APPD 4-12-78
		MATERIAL	APPD 4-14-78
		SPEC NO	DESIGN ACTIVITY APPROVAL
		FINISH	CUSTOMER APPROVAL

varian — MICROWAVE EQUIPMENT DIVISION, SANTA CLARA, CALIFORNIA

ASSEMBLY HIGH VOLTAGE MODULE (INTERCONNECTIONS)

SIZE	CODE IDENT NO		
D	59782	113919	N

SCALE 1/1 SHEET 2 OF 2

(VA) varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE ASSY, H.V. MODULE	LM 113919 — N
CODE IDENT NO 59782	APPROVAL [illegible] DATE 1/26/78	[illegible] 1-26-78	[illegible]

APPLICATION

NEXT ASSEMBLY	USED ON	EO

REVISION

REV	DESCRIPTION	EO	DATE	APPROVED
A	[illegible]	PS 12345	1-24-78	[illegible]
B	[illegible] CHANGE TO AGREE WITH DWG	PS 12345	1-19-78	[illegible]
C	[illegible] CHANGE TO AGREE WITH DWG	PS 12483	[illegible]	[illegible]
D	REVISED PER E.O.	PS 12585	[illegible]	[illegible]
E	INC E.O.	PS13060	8-31-79	TE
F	INC E.O.	PS 13371	11-6-79	TE [illegible]
G	INC E.O.	PS 13372	11-6-79	TE [illegible]
H	INC E O.	PS14751	8-8-80	[illegible]
J	INC. E.O.	PS15047	[illegible]	[illegible]
K	INCORP. E.O	15393	10-7-81	[illegible]
L	INC. E.O.	16692	7-8-82	[illegible] / AE
M	INC. E.O.	18412	3-30-83	[illegible]
N	INC. E.O.	19548	8-18-83	[illegible]

DASH Nº	DISCRIPTION	VA NO
-03	POWER SUPPLY	01003100
-02	POWER SUPPLY	01000167
-01	POWER SUPPLY	156966
-00	TWTA	113979

REVISION STATUS

SHEET																											
LTR																											
SHEET																											
LTR																											
SHEET																											
LTR																											

MICROFILM

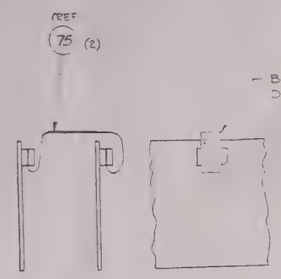
varian | MICROWAVE EQUIPMENT OPERATIONS | ASSEMBLY, HIGH VOLTAGE MODULE | LM 113919 | REV N

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03	-04
1		SCHEMATIC	D113907			ref	-		-	REF
		SCHEMATIC	D135758			-	ref	REF	-	-
2	A1	PCB #1	D113906-00			1	-	-	-	-
3	A2	PCB #2	D135705			1	1	1	-	-
4	T2	HV TRANSFORMER ASSEMBLY	D113994			1	1	1	1	1
5	T1	TRANSFORMER, HEATER	D135770			1	1	1	1	1
6		BASEPLATE	C113913-00			1	-	-	-	1
7		END PLATE	C113915-01			1	1	-	-	1
8		END PLATE	C113915-00			1	1	1	1	1
9		SIDE PLATE	C113917-00			2	1	1	1	2
10		TOP COVER	C113916			1	1	1	1	1
11	J4	WIRE HARNESS	D129822			1	1	1	-	1
12	A1	PCB #1	D113906-01			-	1	1	1	-
13		HEX STANDOFF, 8-32, 5/16 x 3-3/4	22-431010	AMATOM	8421-A-0832-0	2	2	2	2	2
14		HEX STANDOFF, 8-32, 5/16 x 5	22-431009	AMATOM	8426-A-0832-0	2	2	2	2	2
15		END PLATE	01000314			-	-	1	1	-
16		ROUND STANDOFF, 8-32, ½x1-1/4 CER.	24-811801	H.H. SMITH	2610	2	2	2	2	2
17	J1-3	CONNECTOR	51-231852	AMP	862197-1	3	-	-	-	3
18	A2	PCB #2	D135705-01			-	-	-	1	-
19		HEX STANDOFF, M-F, 8-32, 1/4x1-1/4	22-420108	AMATOM	9745-A-0832	2	2	2	2	2
20		SCR 8-32 x 3/8, PHMS, NYLON	12-900708			4	4	4	4	4

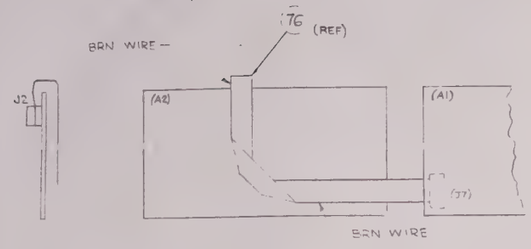
varian | MICROWAVE EQUIPMENT OPERATIONS | ASSEMBLY, HIGH VOLTAGE MODULE | LM 113919 | REV N

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO -00	-01	-02	-03	-04
21										
22		SEALANT	88-298993	DOW CORNING	RTV 3145	AR	-	-	-	A/R
23		LABEL, BLANK	A047481			1	1	1	1	1
24		LABEL, H.V.	B112465-00			1	1	1	1	1
25		LUG, NO. 4	16-139902			1	1	1	1	1
26		SCREW, FLAT HD, 6-32 x 3" LG.	12-112006-40			2	2	2	2	2
27		CABLE TIE	22-119650	PANDUIT	SST1M	5	5	5	5	5
28		TRANSFORMER CLAMP	B113095-01			1	1	1	1	1
29		BASE PLATE	C113913-01			-	1	1	1	-
30		SIDE PLATE	C113917-02			-	1	-	-	-
31	J1	ASSY, HIGH VOLTAGE CABLE	C135751			-	1	-	-	-
32		CLAMP, CABLE	22-117990	TA MFG.	TA1720-08	-	1	-	-	-
33		GROMMET, FLEXIBLE	24-389052	WECKESSER	WG201	-	1	-	-	-
34		SCREW, FLAT HD, 4-40 x 3/8 LG.	12-212004-06			1	1	1	1	1
35		NUT, HEX, 4-40	13-102004			1	1	1	1	1
36		SIDE PLATE	C113917-03			-	-	1	1	-
37	J1	ASSY. HIGH VOLTAGE CABLE	B01000360			-	-	1	1	-
38		SCHEMATIC	D01002996			-	-	-	REF	-
39	J4	WIRE HARNESS	D01002997			-	-	-	1	-
40	A1	PCB #1, MOD	B01003534-07			-	-	-	-	1
41	A2	PCB #2, MOD	B01003534-08			-	-	-	-	1

FORM 1758 02 375



DETAIL B



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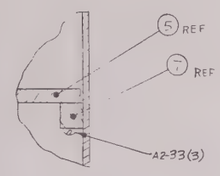
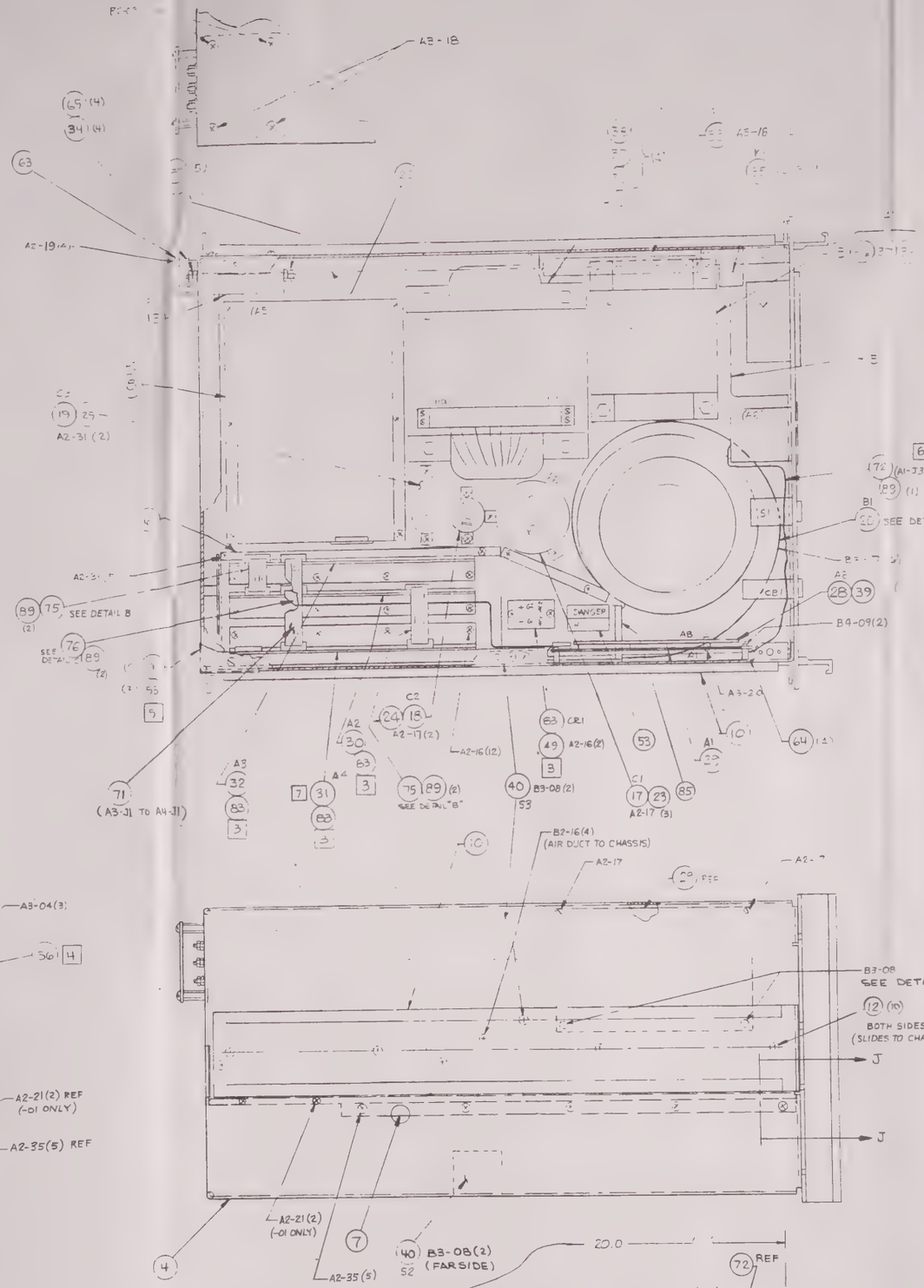
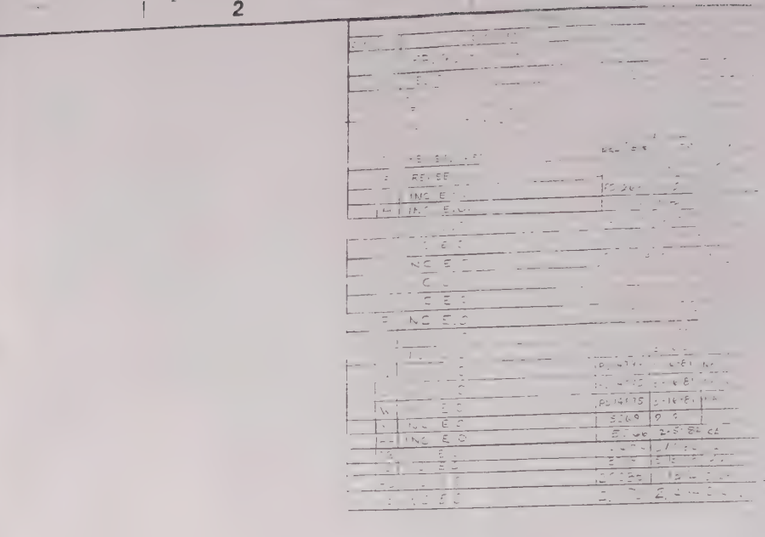
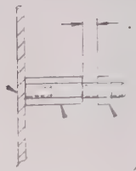


VIEW J-J

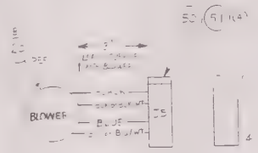


DETAIL "F"
WIRING TO A-6

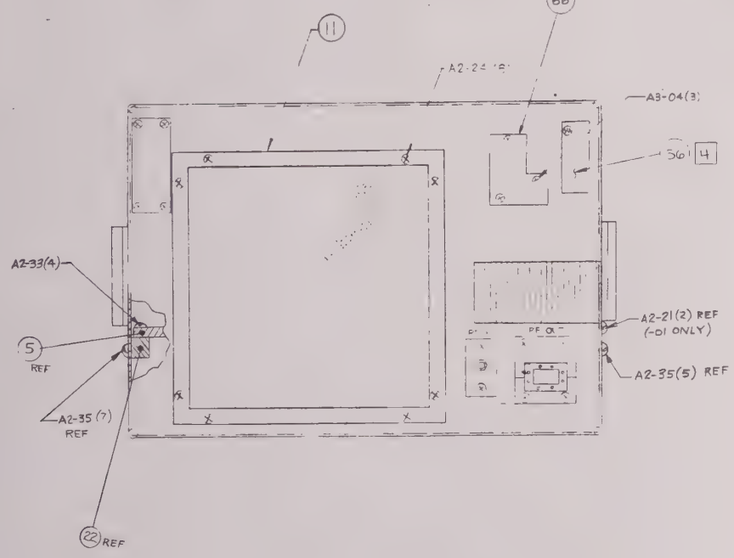


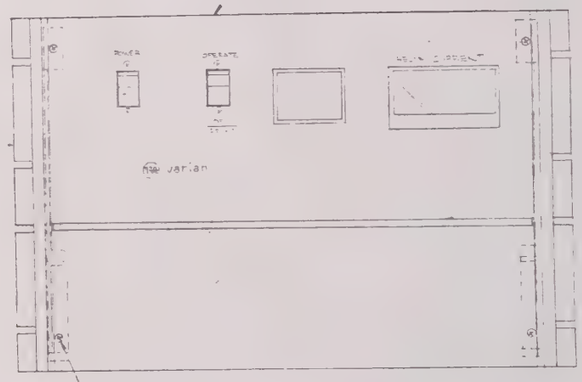


DETAIL "D"
SCALE: NONE



DETAIL F





B3-03 (4)

7 ADD JUMPER A-B USING # 20 AWG WIRE TO 129405 (ITEM 31 OF 113979-05, -06, -07 & -17)

6 CONNECT CABLE, ITEM (72), TO A6 PER DETAIL F, BEFORE ASSEMBLING FRONT PANEL ASSY, ITEM (3), UNTO CHASSIS.

5. PLACE WARNING LABELS ITEM (53), ON TOP AND BOTTOM COVERS, TOWARDS THE REAR OF THE UNIT ALONG THE CENTERLINE.

4. TYPE LABEL INFORMATION FROM FAMILY TREE ON ITEM (56). SPRAY COVER TOP WITH CLEAR PLASTIC SPRAY COATING.

3. APPLY A UNIFORM THIN COATING OF HEATSINK COMPOUND ITEM 88 TO ITEM 30, 31, 32, 49, AND 57 BEFORE INSTALLATION.

2. ASSEMBLE USING HARDWARE DWG 0110625.

1. ASSEMBLE PER VARIAN WORKMANSHIP STD 87-800 192.

NOTES:

SEE SEPARATE LM 113979

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	CONTRACT NUMBER		
DECIMALS: 1PL ± .3 2PL ± .03	DR	F SAMBLE	5-23-77
3PL ± .015 FRAC ± 1/64	CHK	T Rocca	1-27-78
ANG ± 1° SURFACE FINISH ✓	APPD	[illegible]	2/6/78
MATERIAL	APPD	P H Lund	2-7-78
	DESIGN ACTIVITY APPROVAL		
NEXT ASSEMBLY / USED ON	SPEC NO.	CUSTOMER APPROVAL	
APPLICATION	FINISH		

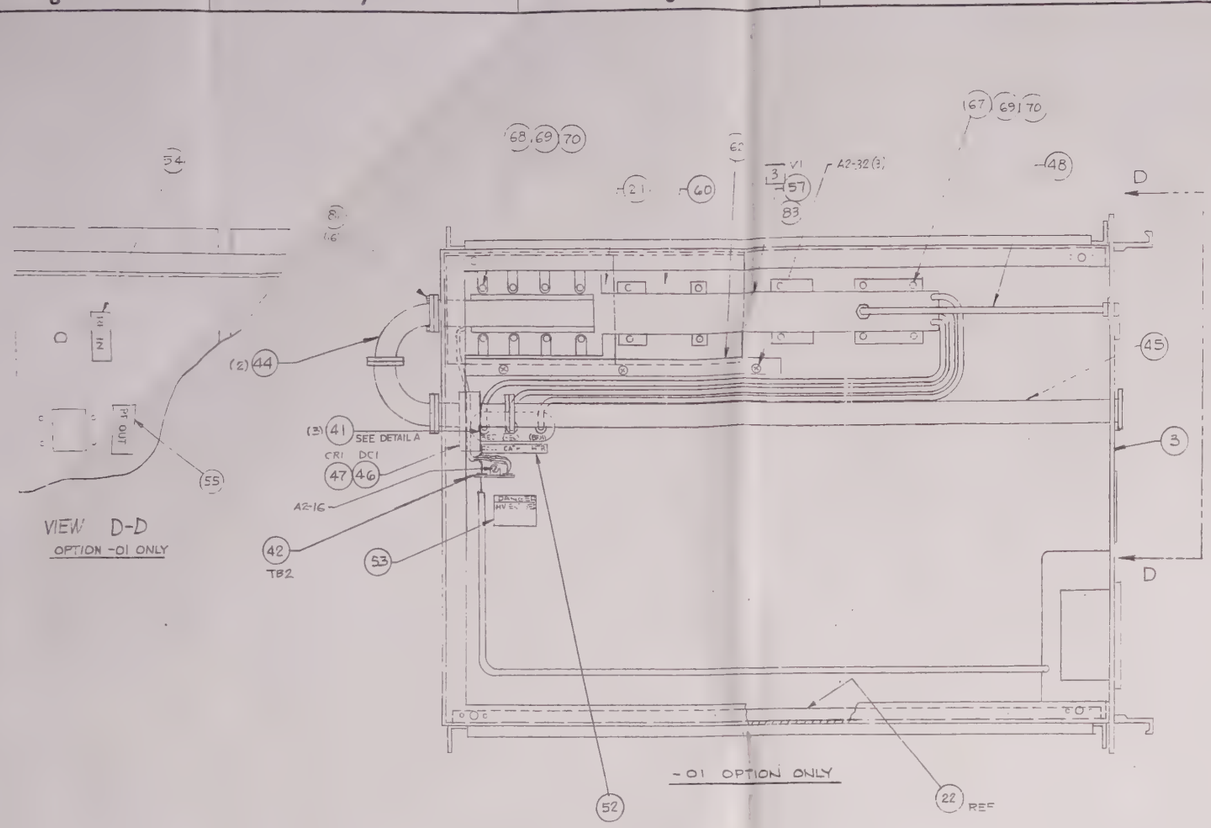
varian — MICROWAVE EQUIPMENT OPERATIONS, SANTA CLARA, CALIFORNIA

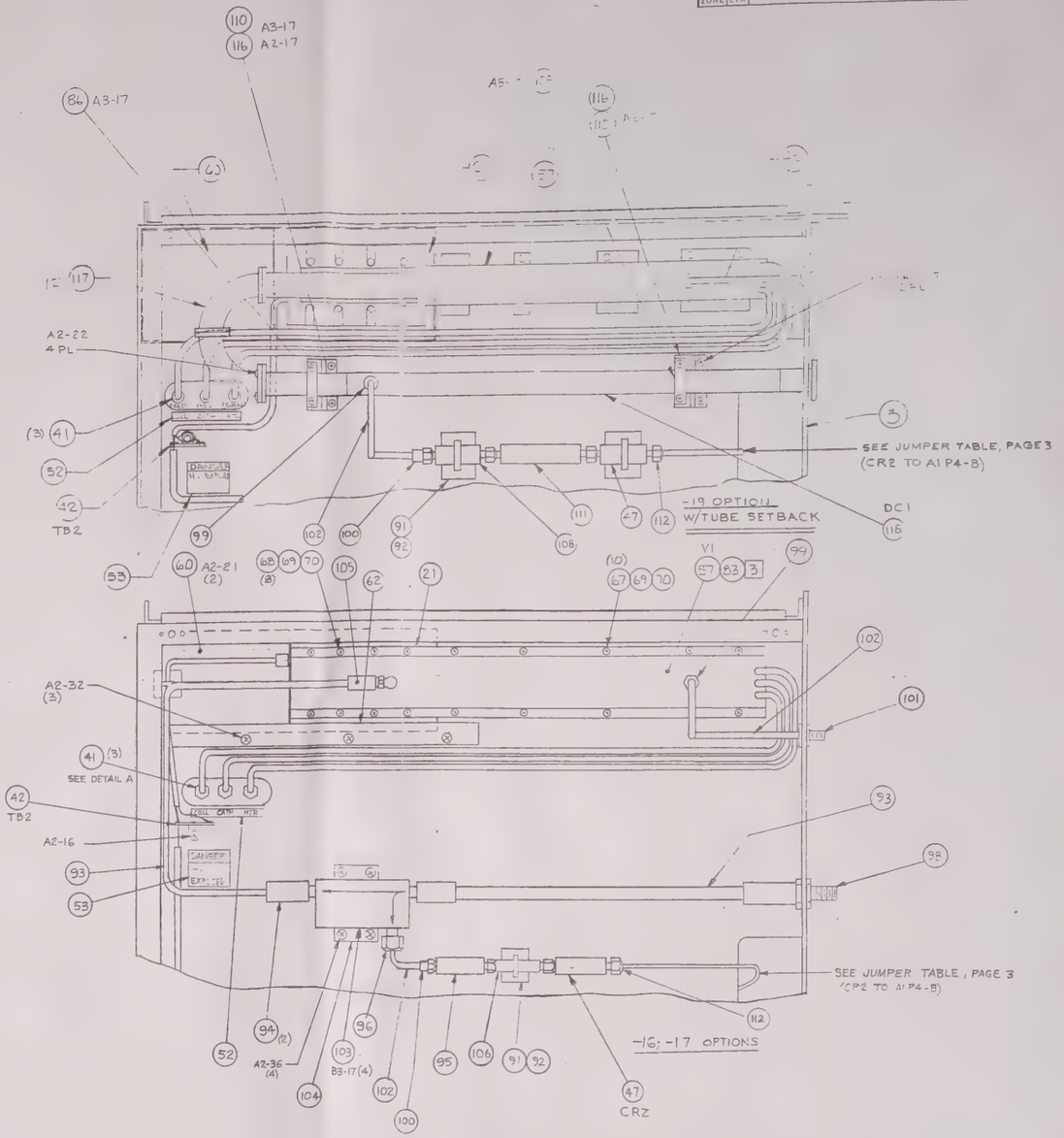
ASSEMBLY 100/200W TWTA

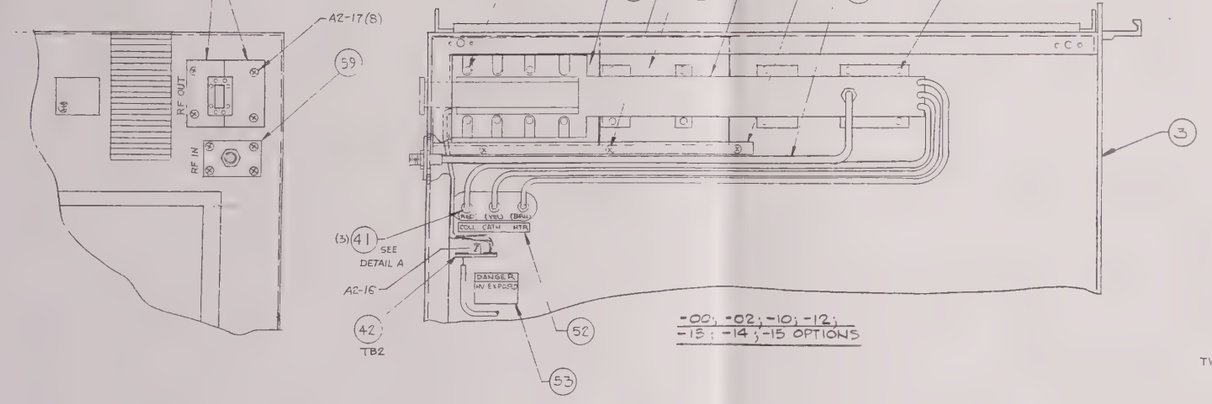
SIZE E | CODE IDENT NO. 39762 | 113979 | 05

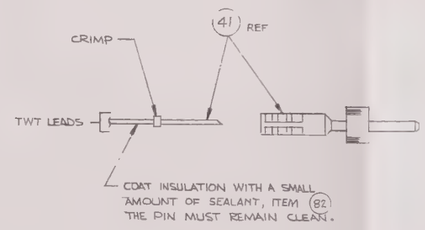
SCALE | SHEET 1 OF 1

REVISIONS				
ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED

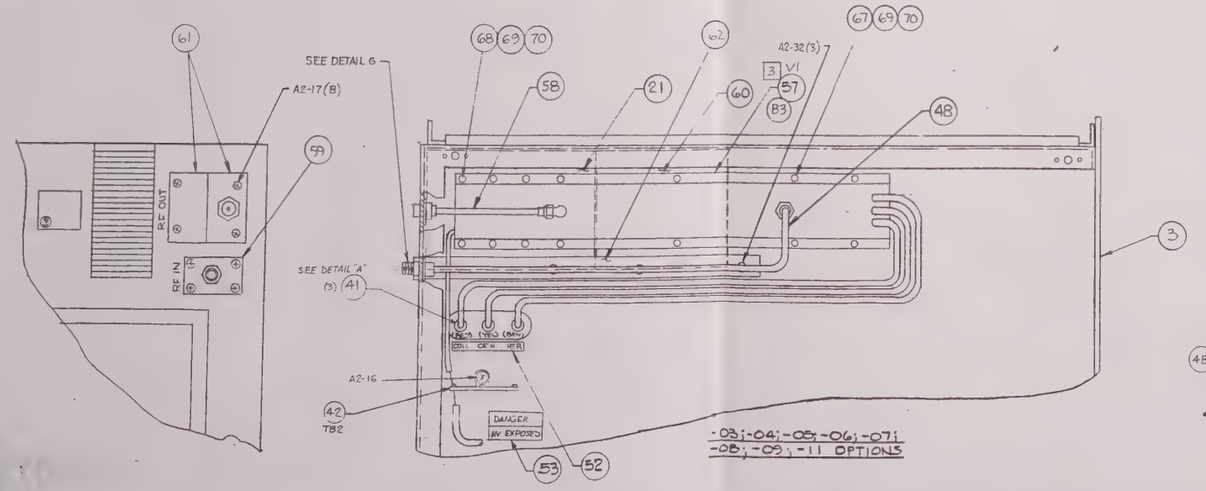


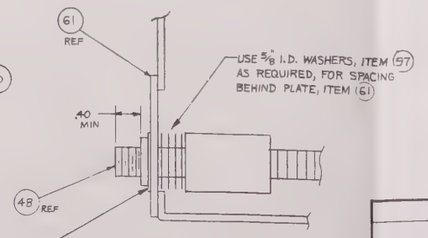






DETAIL "A"
POTTING HV CONNECTORS





DETAIL G

SEE SEPARATE LM 113979

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS: 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO.
FINISH
NEXT ASSEMBLY 100/200W TWTA
USED ON
APPLICATION

CONTRACT NUMBER
DR F. [illegible] 1-9-78
CHK K. Rose 1-27-78
APPD [signature] 2/6/78
APPD [signature] 2-7-78
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian — MICROWAVE EQUIPMENT OPERATIONS, SANTA CLARA, CALIFORNIA

ASSEMBLY
100/200W TWTA

SIZE	CODE IDENT NO		
E	59782	113979	AE

SCALE ~ SHEET 2 OF 3

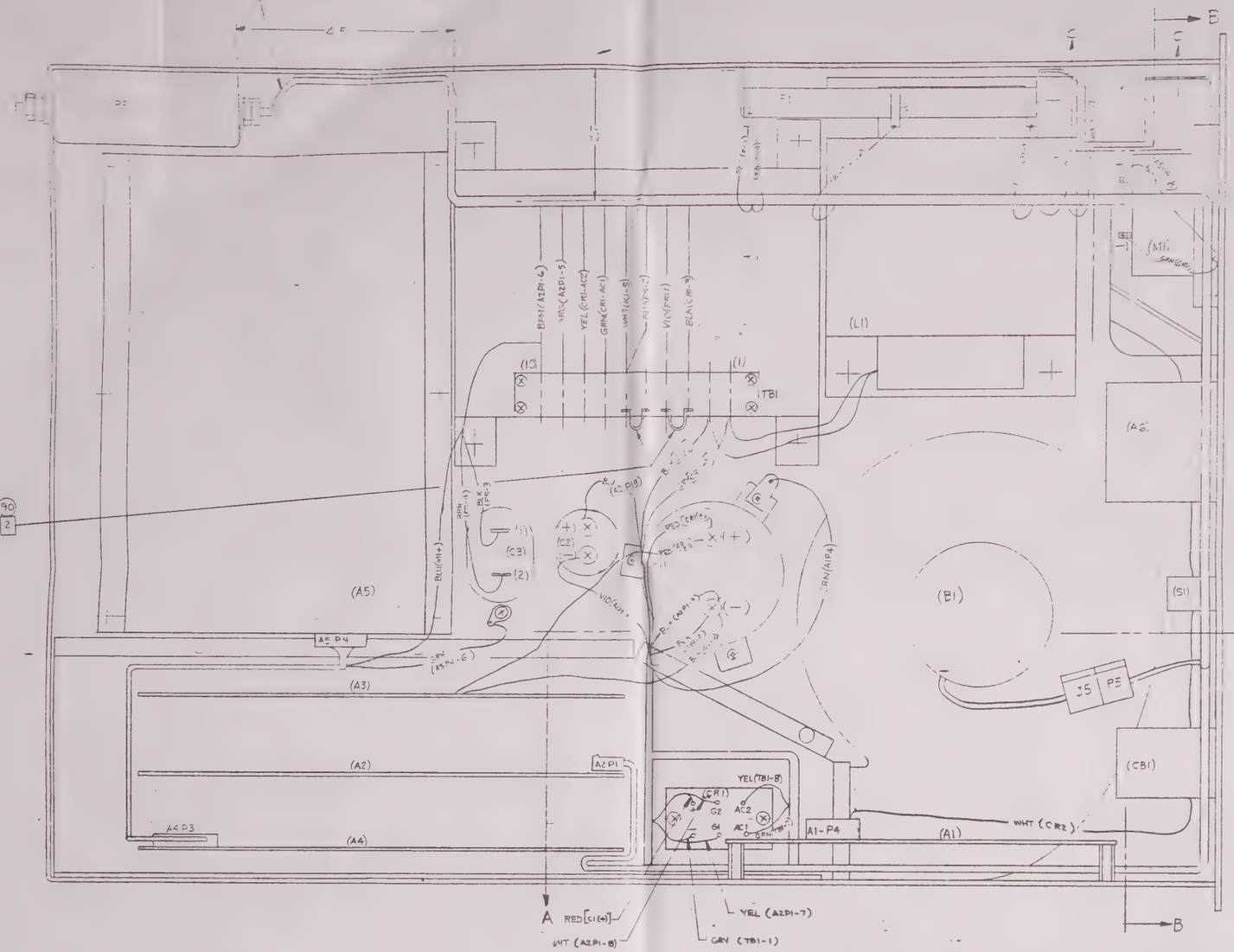
SUPERSEDES

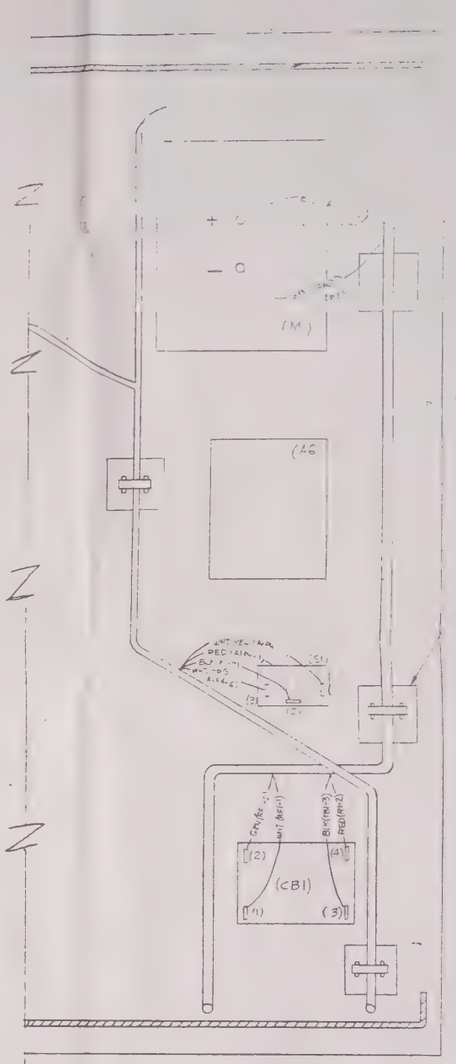
3440-99-08.11/72

MICROFILM

113979

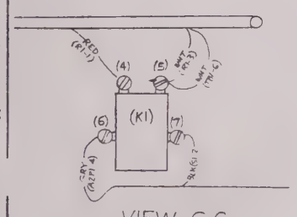
WHT (CB1-1) TO UPPER TERMINAL
GRN (CB1-2) TO LOWER TERMINAL



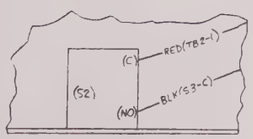


VIEW B-B

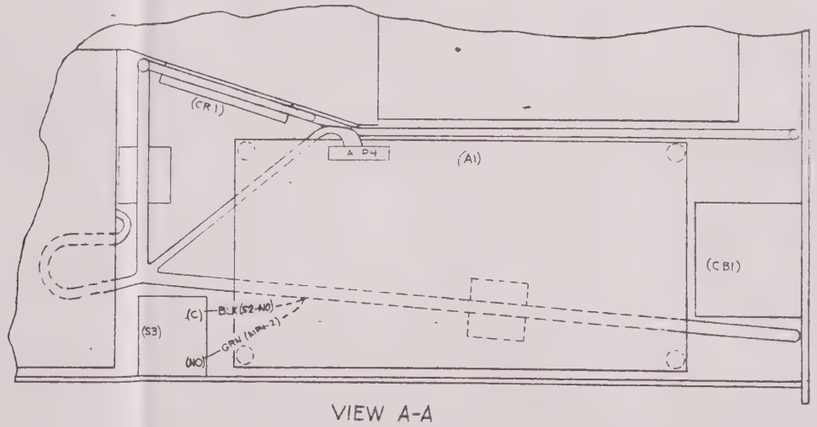
WIRING HARNESS			
NO.	FROM	TO	COLOR
0-1	C3-1	P5-3	BLK
0-2	A5 P4-1	A4P3-7	
0-3	C1(-)	A2P-1	
0-4	S1-2	K-7	
0-5	TB1-3	CB1-3	
0-6	S2-NO	S3-COM	
5-8	RF1-2	CB1-2	GRN
1-1	C3-2	P5-4	BRN
1-2	A5P4-2	A4P3-8	
	TB1-10	A2P1-6	
	[illegible]	A4P3-9	RED
	TB1-6	[illegible]	[illegible]
	[illegible]	[illegible]	WHT
	[illegible]	[illegible]	RED
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	TB1-5	[illegible]	
	TB1-4	[illegible]	
7-2	D2(-)	A2P-2	
7-3	A5P4-7	A4P3-1	
8-1	A5P4-14	A4P3-10	GRY
9-1	A5P4-15	A4P3-11	WHT
9-2	A1P4-4	TB2-2	
90-1	A5P4-16	A4P3-12	WHT/BLK
5-5	A5P4-6	GND LUG	GRN
92-1	A5P4-17	A4P3-5	WHT/RED
9-3	TB1-10	A2P1-9	WHT
93-1	A5P4-5	S1-3	WHT/ORG
94-1	A5P4-7	S1-1	WHT/YEL
2-9	R1-1	R1-2	RED
5-6	GND LUG	[illegible]	GRN
2-8	K1-4	R1-1	RED
6-2	TB1-1	CR1 (-)	GRY
5-8	TB1-2	C1 (-)	BLK
94	A5P4-16 (CENTER)	A4P3-2	WHT
	A5P4-13 (SHIELD)	A4P3-6	
5-9	R(A1P4-1)	K(GND)	GRN



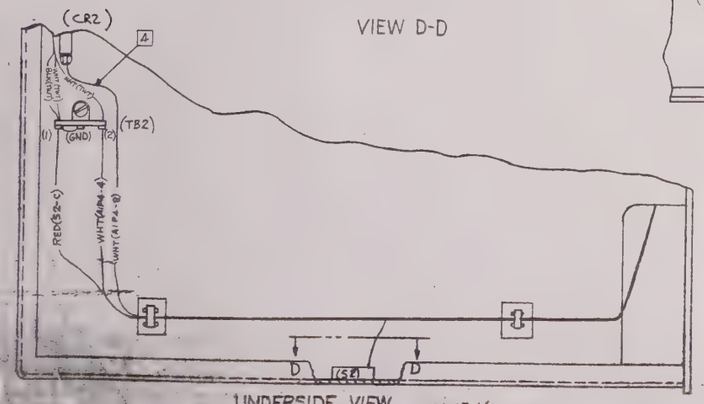
VIEW C-C



VIEW D-D



VIEW A-A



UNDERSIDE VIEW SCALE 1/2

WIRE & CONNECTIONS NOT INCLUDED IN WIRING HARNESS												
NO.	FROM	TERMINATION TYPE	TERMINATION PART NO	TO	TERMINATION TYPE	TERMINATION PART NO	WIRE TYPE	WIRE PART NO.	AWG	COLOR	LENGTH
1	TB1-1	#8 LUG	15-60415	L1-1				SUPPLIED WITH L1			6"
2	TB1-2	#8 LUG	15-60415	L1-2				SUPPLIED WITH L1			6"
3	C1 -	#10 LUG	15-60412	A3-B4				CONNECT WITH A3			10"
3	C1 +	#10 LUG	15-60412	A3-E9				SUPPLIED WITH A3			10"
4	5	CR2	SAM PLUG	58-180107	A1P4-8	SEE WIRING HARNESS		SEE WIRING HARNESS				4'0"
	TWT			TB2-1				SUPPLIED WITH TWT		BLK		
	TWT			TB2-1						WHT		
	TWT			TB2-2						WHT		
	TB2-1			TB2-GND			BARE	81-033824	24			3"

4 JUMPER 6 TO BE USED WITH 113979-01-K4-17 OPTIONS ONLY. CUT BACK AND INSULATE SHIELD CONNECTION AT A1P4 END.
3 JUMPER 3 & 4 ARE SELF-LEADS FROM A3 AND ARE TO BE TWISTED TOGETHER.
5 SECURE HARNESS TO CHASSIS USING ADHESIVE BACKED CABLE CLAMPS, ITEM 91, AND CABLE TIE ITEM 92.
2 CONNECTIONS ARE SHOWN FOR 110V OPERATION. FOR 220V OPERATION REMOVE BOTH STRAPS, ITEM 90, FROM TB1-3 TO TB1-4 AND TB1-5 TO TB1-6 AND INSTALL ONE STRAP FROM TB1-4 TO TB1-5. REMOVE JUMPER(RED WIRE) BETWEEN R1-1 AND R1-2. TRANSFER RED WIRE (CB1-4) FROM R1-2 TO R1-1. TRANSFER WHITE WIRE (K1-5) FROM R1-3 TO R1-2.
1 LEGEND: BLACK(P5-6) = WIRE COLOR(DESTINATION).

NOTES:

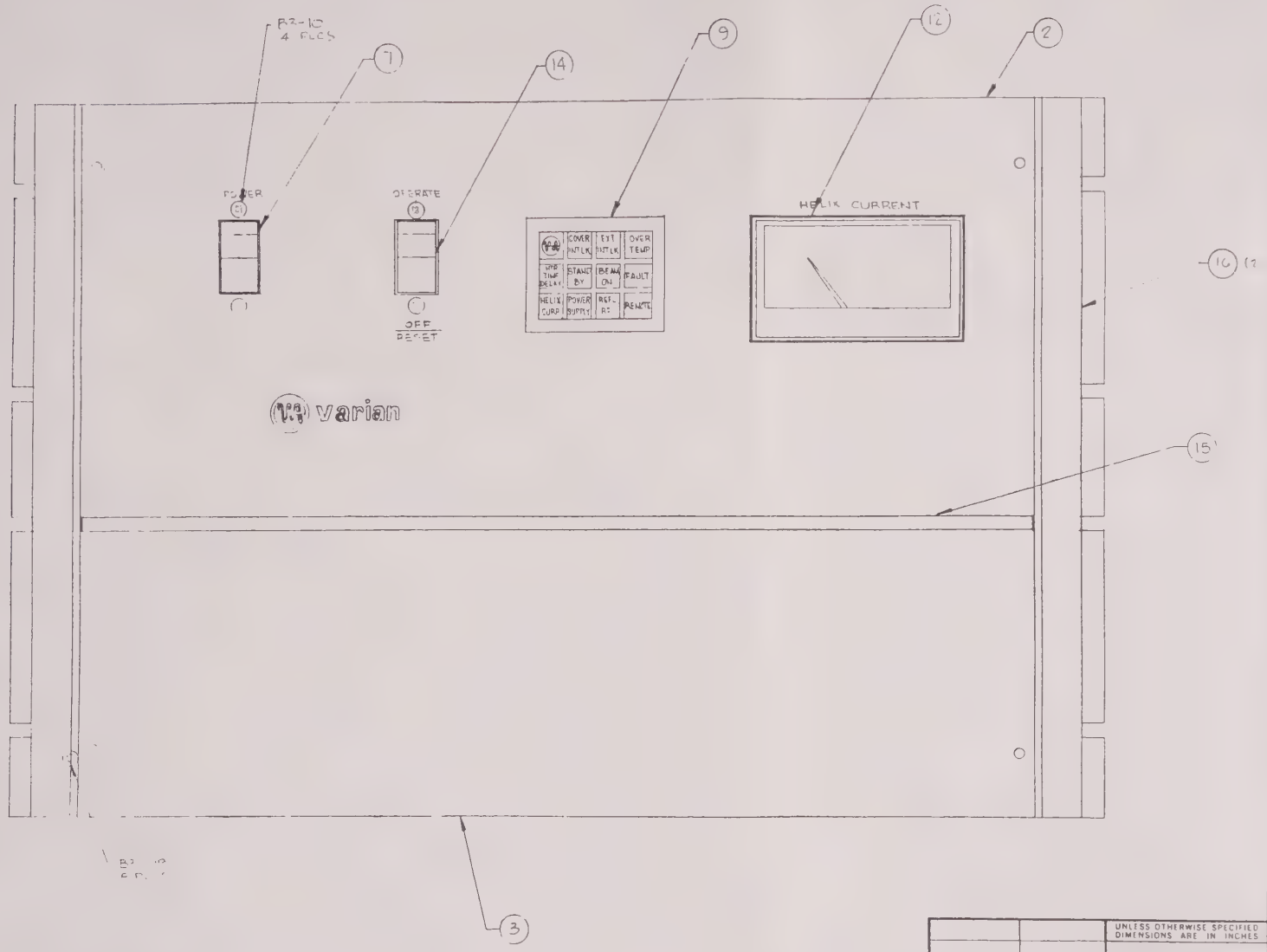
QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	CONTRACT NUMBER	varian MICROWAVE EQUIPMENT OPERATIONS SANTA CLARA, CALIFORNIA	
		DECIMALS: 1PL ± .3 2PL ± .03	DR K. PROCCO 2/13/78	ASSEMBLY 100/200 W TWTA (INTERCONNECTIONS)	
		3PL ± .015 FRAC ± 1/64	CHK L. Ando 2/28/78		
		ANG ± 1° SURFACE FINISH ✓	APPD [signature] 2/28/78		
		MATERIAL	APPD [signature] 3-22-78		
	100/200 W TWTA		DESIGN ACTIVITY APPROVAL	SIZE E	CODE IDENT NO. 59782
NEXT ASSEMBLY	USED ON	SPEC NO.	CUSTOMER APPROVAL	DRAWING NO. 113979	REV
APPLICATION		FINISH		SCALE 1/1	SHEET 3 OF 3

SUPERSEDES

REVISIONS					
ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	A	VARIAN LABEL REPLACED WITH SILKSCREEN REL TO MFR.	PS-12286	12-21-77	TF
	B	INCORPORATE EO	PS 12353	3-15-78	
	C	LM REVISED. ADDED -01 OPTION	PS 12446	3-15-78	
	D	LM REVISED. ADDED -02 OPTION	PS 12516	5-26-78	
	E	LM REVISED. ADDED -03 OPTION	PS 12614	5-26-78	



SEE SEPARATE LM 129054

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

113979	100/200 W TWTA
NEXT ASSEMBLY	USED ON
APPLICATION	

CONTRACT NUMBER

DR	F. GAMBLE	5-17-77
CHK		5-25-77
APPD		
APPD		12-21-77

DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA, CALIFORNIA

FRONT PANEL ASSEMBLY

SIZE	CODE IDENT NO	
D	99313	129054 F

SCALE 1/1 SHEET 1/1

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE: ASSEMBLY, FRONT PANEL	LM 129054	REV E
CODE IDENT NO. 99313	APPROVAL [signature] DATE 1-26-78	[signature] 1-26-78	0408A	

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
E 113979	100/200W TWTA	PS 12345	A	REL TO MFR	PS 12345	1-20-78	K.R.
			B	CHANGE ON DRAWING	PS 12353	1-24-78	K.R.
			C	ADD -01 OPTION	PS 12446	3-7-78	K.R.
			D	ADD -02 OPTION	PS 12516	5-26-78	K.R.
			E	ADD -03 OPTION	PS 12614	5-26-78	K.R.

REVISION STATUS

SHEET																												
LTR																												
SHEET																												
LTR																												
SHEET																												
LTR																												

FORM 1758-01-375

varian | MICROWAVE EQUIPMENT OPERATIONS | ASSEMBLY, FRONT PANEL | LM 129054 | REV E

ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
1									
2		FRONT PANEL, UPPER	D129052			1	1	1	1
3		FRONT PANEL, LOWER	D129053-00			1	-	-	-
		FRONT PANEL, LOWER	D129053-01			-	1	-	-
/		FRONT PANEL, LOWER	D129053-02			-	-	1	-
7	CB1	CIRCUIT BREAKER,30 AMP,50/60 Hz	55-700375	AIRPAX	UPGX-66-1-61-303-01	1	1	1	1
8									
9	A6	STATUS INDICATOR DISPLAY	129075	INDUSTRIAL ELEC.ENG.INC.	0280-01-SPEC-1815	1	1	1	1
10									
11									
12	M1	METER, 0-100 Ma	76-125901	BEEDE	QAB-35, MBPJ935736	1	1	1	1
13									
14	S1	SWITCH SPDT	71-219820	CUTLER HAMMER	8134K22A1V52	1	1	1	1
15		SPACER, FRONT PANEL	112882-02			1	1	1	-
16		HANDLE	B112491-05			2	2	2	2

REVISIONS				
ZONE	LTR	DESCRIPTION	EO	DATE
	A	REVISED PER ENG REQUEST		10-10-77
	B	REVISED RELEASED TO PRODUCTION	PS12345	1-18-78
	C	REVISED & INC E.O.	PS12537	8-2-78
	D	REVISED	~~~	9-6-78
	E	INC E.O.	PS12538	10-27-78
	F	INC E.O.	PS12569	10-27-78
	G	INC E.O.	PS12598	10-27-78
	H	INC E.O.	PS12602	10-27-78
	J	INC E.O.	PS12909	11-1-78
	K	INC E.O.	PS13374	1-18-80
	L	INC E.O.	PS14871	12-15-80
	M	INC E.O.	PS14976	5-16-81
	N	INC EO	PS15185	8-5-81
P		INC E.O.	PS15175	8-5-81
R		INC E.O.	PS15185	8-5-81

REFERANCE DESIGNATIONS		
BOARD	LAST USED	UNUSED
1A5	C8, CR7, Q6, R15, U7	
1A1A2	C31, CR10, J6, Q9, R63, U14	

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS		

C113989	100/200W TWTA	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	CONTRACT NUMBER
D113984	100/200W TWTA	DECIMALS: 1PL ± 2PL ±	DR Willie Evans 5-25-77
NEXT ASSEMBLY	USED ON	3PL ± FRAC ± 1/64	CHK JHT 6/17/77
APPLICATION		ANG ± SURFACE FINISH ✓	APPD [signature] 1-18-78
		MATERIAL	APPD RA Ewald 1-26-78
		SPEC NO.	DESIGN ACTIVITY APPROVAL
		FINISH	CUSTOMER APPROVAL

varian — MICROWAVE EQUIPMENT OPERATIONS, SANTA CLARA, CALIFORNIA

LOGIC SCHEMATIC

SIZE E | CODE IDENT NO. 59782 | 129076 | REV B

SCALE ~ | SHEET | OF

SUPERSEDES MICROFILM

NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, ¼ WATT COMP 5%, AND ALL CAPACITORS ARE IN MICROFARADS.

LOGIC (+12V) GND

-15V RETURN

TRUTH TABLE - CD4044AE

S	R	Q
0	0	0
0	1	1
1	0	0
1	1	NC

TRUTH TABLE VALID WITH LOGIC "1" ON PIN 5 OF CD4044AE.

J3

LOGO COMM	1	16	LOGO POS (+15VDC)
COVER INT'L	2	15	REMOTE INT'L
TWT TEMP	3	14	TIME DELAY
STANDBY	4	13	BEAM ON
FAULT	5	12	HLX FAULT
PS FAULT	6	11	REFL FAULT
REM CONT	7	10	NC
NC	8	9	NC

TO ANUNCIATOR ON FRONT PANEL

J7

SW REG CONT	1	16	IND COMM
SW REG CONT	2	15	200V UV ENABLE
IND COMM	3	14	SUM FAULT
SUM FAULT	4	13	LOW LINE INHIBIT
+15VDC	5	12	+15 VDC
HLX FAULT	6	11	N.C.
N.C	7	10	+12VDC
AUTO RESET	8	9	NC

TO/FROM OSC BIAS PCB

J4

1	COMMON
2	INTERLOCK
3	IND. RESET
4	TWT TEMP
5	IND COMM
6	HV ON
7	HV OFF
8	REFL PWR FAULT
9	+12VDC

J1 / J2

	J1	J2
1	16	16
2	15	15
3	14	14
4	13	13
5	12	12
6	11	11
7	10	10
8	9	9

SEE REMOTE PCB SCHEMATIC NO. 112860 FOR PIN CONNECTION TO J1 AND J2. J1 & J2 USED ONLY WITH REMOTE OPTION.

SPARE GATES (1A5)

U6, CD4093AE

U4, CD4044AE

SPARE GATES (1A, A8)

U10, CD4044AE

U11, CD4044AE

U12, CD4066AE

U3, CD4049AE

U6, CD4049AE

CD4093AE

CD4011AE

CD4049

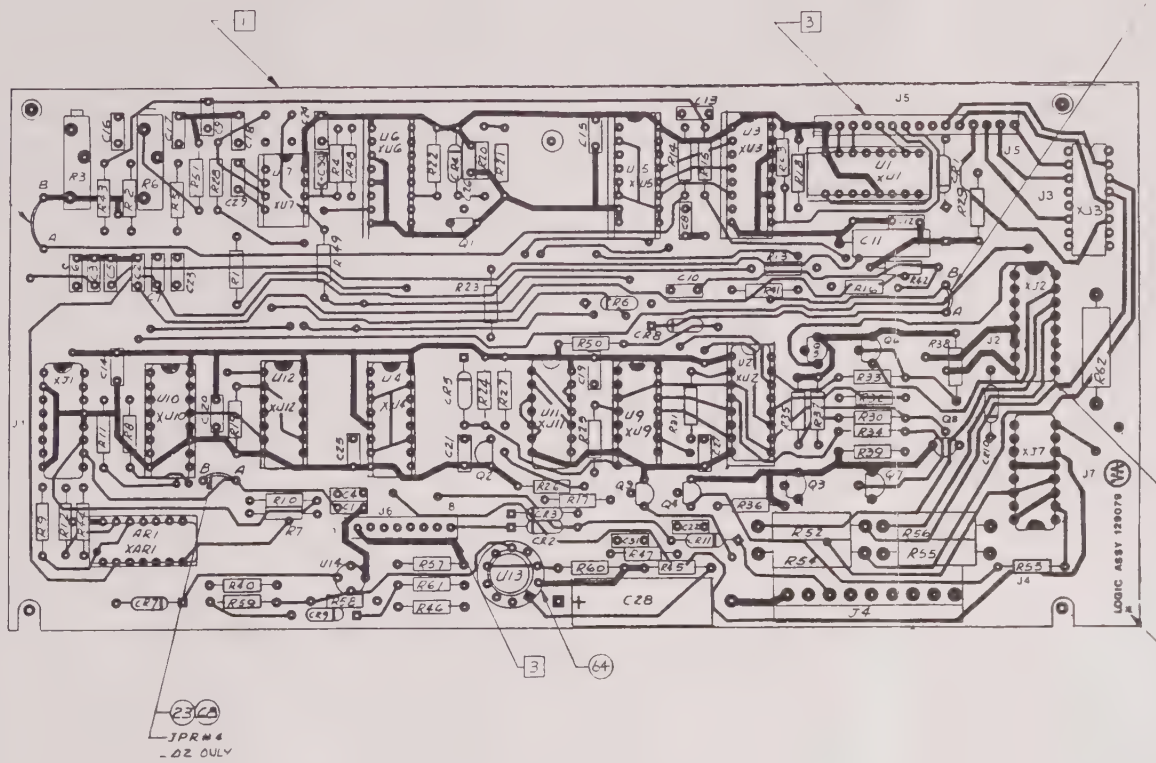
CD4066A

CD4044AE

FAULT/RECYCLE INDICATOR PWB C129083 (OPTIONAL)

LOGIC PWB C129079

REVISIONS					
ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	O	REVISED AND REDRAWN	PS14975	5-18-81	
	R	INC EO	PS15166	8-5-81	
	T	INC EO.	PS15175	8-5-81	
	U	INC EO.	PS15185	8-5-81	
	V	INC E.O.	15333	9-23-81	
	W	PICTURE CHNG EO PS	15182	10/20/81	



JPRM3 - 24 68
-02 & 04 ONLY

22 68
JPR #2
-01 ONLY

25 CB
FARSIDE 3 PLCS
JPR6
JPR7
JPR8
REMOVE SOCKET XJ2, & ADD C37-C39
DETAIL "A"
-03 VERSION ONLY

FOR -03 VERSION SEE DETAIL "A"

J4 (REF)

SEE SEPARATE LIST OF MATERIAL- LM129079

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS		

3 MOUNT SHORT PINS IN PCB FOR J5 & J6

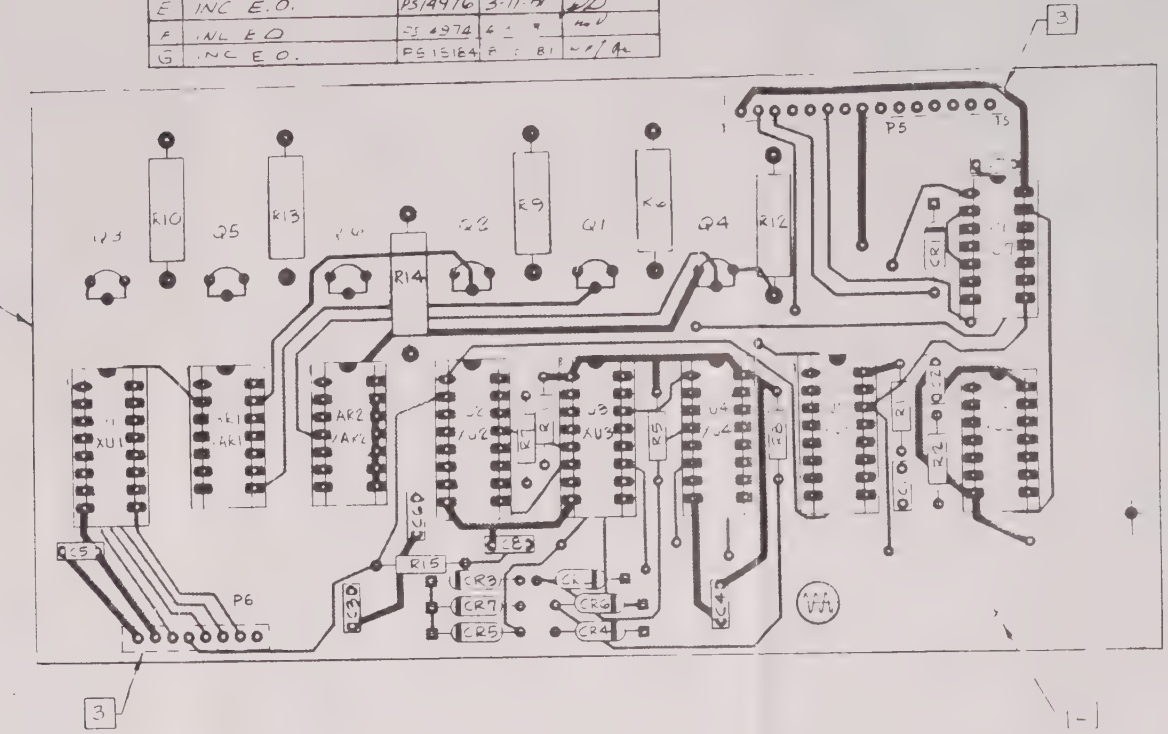
2 MARK CURRENT REVISION LETTER OF ASSEMBLY, & CORRECT DASH NO.

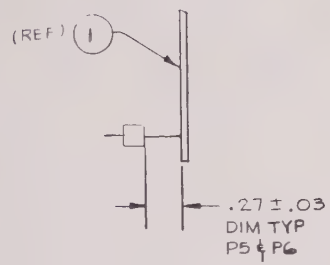
1 ASSEMBLE/VARIAN WORKMANSHIP STD. 87-800-192

NOTES:

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		CONTRACT NUMBER	varian
DECIMALS 1PL ± .1 2PL ± .02		DR	5-15-81
3PL ± .005	FRAC ± 1/64	CHK	5-18-81
ANG ± 1°	SURFACE FINISH ✓	APPD	9/19/81
MATERIAL		APPD	5/19/81
E113979	100/200W TWTA	DESIGN ACTIVITY APPROVAL	ASSEMBLY LOGIC PCB
NEXT ASSEMBLY	USED ON	CUSTOMER APPROVAL	SIZE D / CODE IDENT NO 59782 / 129079 / W
APPLICATION	SPEC NO		SCALE 2X / SHEET 1 OF 1
	FINISH		

B	INC E.O.	[illegible]	[illegible]	[illegible]
C	INC E.O.	PS 4565	[illegible]	[illegible]
D	INC E.O.	PS 3295	[illegible]	[illegible]
E	INC E.O.	PS 4976	3-11-81	[illegible]
F	INC E.O.	PS 4974	[illegible]	[illegible]
G	INC E.O.	PS 15164	[illegible]	[illegible]





DETAIL "A"

SEE SEPARATE LIST OF MATERIAL LM129083

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

3 J5 & J6 MOUNTED ON FAR SIDE, SEE DETAIL "A".

2 MARK CURRENT REVISION LETTER OF ASSEMBLY.

1. ASSEMBLE/VARIAN WORKMANSHIP STD 87-800-299.

NOTES:

E113979	
NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

DECIMALS 1PL ± .1 2PL ± .02

3PL ± .005 FRAC ± 1/64

ANG ± 1 SURFACE FINISH ✓

MATERIAL

SPEC NO

FINISH

CONTRACT NUMBER

DR [illegible] 1/1/78

CHK [illegible]

APPD [illegible] 1/11/78

APPD [illegible] 1-26-78

DESIGN ACTIVITY APPROVAL

CUSTOMER APPROVAL

varian

MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA, CALIFORNIA

ASSEMBLY
FAULT/RECYCLE PWB
(COMPONENT SIDE)

SIZE	CODE IDENT NO		
C	59782	129083	G

SCALE 2X SHEET 1 OF 1

SUPERSEDES

129083

SHEET 1 [illegible] 3

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE: ASSEMBLY, FLT/RECYCLE/IND PWB	LM 129083	REV G
CODE IDENT NO. 59782	APPROVAL [signature]	DATE 6/2/[illegible]	[signature] 1-26-[illegible]	[signature]

APPLICATION

NEXT ASSEMBLY	USED ON	EO
E113979	100/200W TWTA	
E113979-20		

REVISION

REV	DESCRIPTION	EO	DATE	APPROVED
A	REVISED AND RELESED MFG	PS12345	1-10-78	JHT
B	INC. E.O.	PS12517	10/30/78	MHS
C	INC. E.O.	PS12565	10/30/78	MHS
D	INC. E.O.	PS13295	12-19-79	WF [illegible]
E	INC E.O	PS14976	3-[illegible]	[signature]
F	INC. E.O	PS14974	5-14-81	[signature]
G	INC E.O	PS15184	8-10-81	[signature]

REVISION STATUS

SHEET																												
LTR																												
SHEET																												
LTR																												
SHEET																												
LTR																												

FORM 1758 01 375

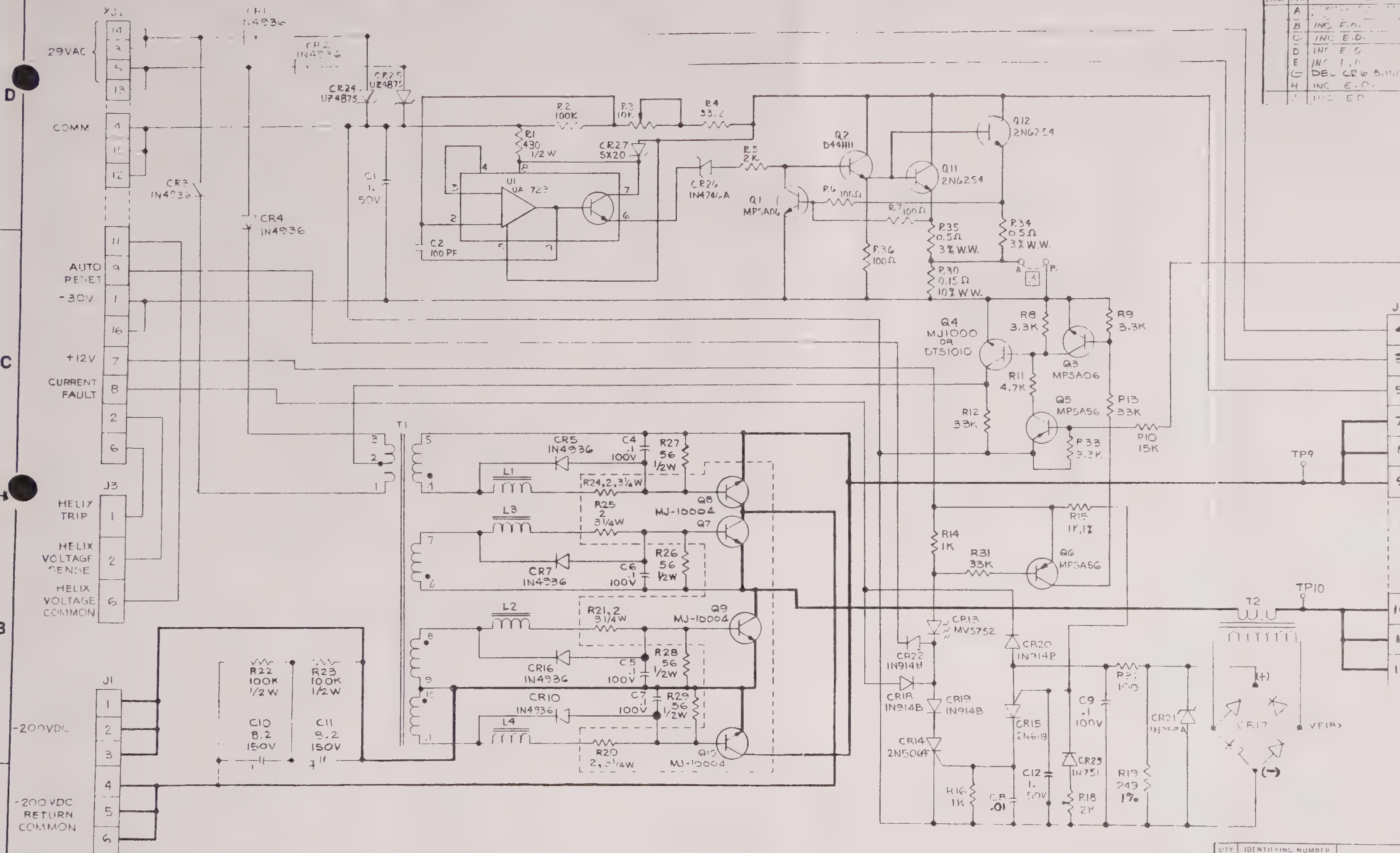
varian	MICROWAVE EQUIPMENT OPERATIONS	ASSEMBLY, FLT/RECYCLE/IND PWB	LM 129083	REV G

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
1		FABRICATION PWB	C129082			1			
2		SCHEMATIC	E129076			REF			
3									
4	C2-C7	CAPACITOR, CERAMIC, .01 µf, 200V	41-229951		CK06BX103K	6			
5	C1, 8	CAPACITOR, CERAMIC, .1 µf, 100V	41-229952		CK06BX104K	2			
6	CR1-CR7	DIODE, SIGNAL	66-320914		1N914B	7			
7									
8									
9	Q1-Q6	TRANSISTOR, NPN	62-920006	MOT	MPS-A14	6			
10	R15	RESISTOR, COMP., 10K, 1/4W, 5%	32-301510		RC07GF103J	1			
11	R1, 5, 7, R8, 11	RESISTOR, COMP., 100K, 1/4W, 5%	32-301610		RC07GF104J	5			
12	R2	RESISTOR, COMP., 1.5 MEG, 1/4W, 5%	32-301715		RC07GF155J	1			
13	R6, 9, 10, R12-14	RESISTOR, COMP., 18 OHM, 1W 5%	33-301218		RC32GF180J	6			
14	AR1, 2	RESISTOR, NETWORK, 100K	31-400023	ALLEN-BRADLEY	314B104	2			
15									
16									
17									
18	U1, U3	I.C.-HEX BUFFER/INVERTER	62-600032	RCA	CD4049AE	2			
19	U2	I.C.-DUAL BINARY UP-COUNTER	62-600691	RCA	CD4520BE	1			
20	U4	I.C.-QUAD 3 STATE R/S LATCHES	62-600684	RCA	CD4044AE	1			
21	U5	I.C.-14 STAGE CNTR/DIVIDER/OSC	62-600692	RCA	CD4060AE	1			

varian	MICROWAVE EQUIPMENT OPERATIONS	ASSEMBLY, FLT/RECYCLE/IND PWB	LM 129083	REV G

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO			
						-00	-01	-02	-03
22	U6	I.C.-QUAD 2 INPUT NAND	62-600687	RCA	CD4093BE	1			
23	U7	I.C.-QUAD 2 INPUT NAND	62-600006	RCA	CD4011AE	1			
24									
25									
26	XU1-5	SOCKET I.C. - 16 PIN	54-634008	SAE	CSA3100-16B	5			
27	XU6,7 XAR1,2	SOCKET I.C. - 14 PIN	54-634007	SAE	CSA3100-14B	4			
28	P5	CONNECTOR, 15 CIRCUITS	51-190121	CKT ASSY CORP	CA-S15-SP100-230-730	1			
29	P3	CONNECTOR, 8 CIRCUITS	51-190122	CKT ASSY CORP.	CA-S08-SP100-230-730	1			

ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	A	[illegible]	[illegible]	10-10-77	[illegible]
	B	INC E.O.	[illegible]	10-27-78	[illegible]
	C	INC E.O.	[illegible]	[illegible]	[illegible]
	D	INC E.O.	[illegible]	9-10-80	[illegible]
	E	INC E.O.	[illegible]	[illegible]	[illegible]
	G	DEL CR6 8,11,12 - SC 14-81	14980	5/4/81	LMH/JHT
	H	INC E.O.	15348	9-19-81	[illegible]
	J	INC E.O.	[illegible]	1/20/81	[illegible]



NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTOR VALUES ARE IN OHMS, 5%, 1/4W.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
3. TUNE L_ AT ... AMP HEATER SURGE CURRENT.

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

NEXT ASSEMBLY	USED ON
D129-105-02	[illegible]
D129-105-00	[illegible]

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH
MATERIAL
SPEC NO
FINISH

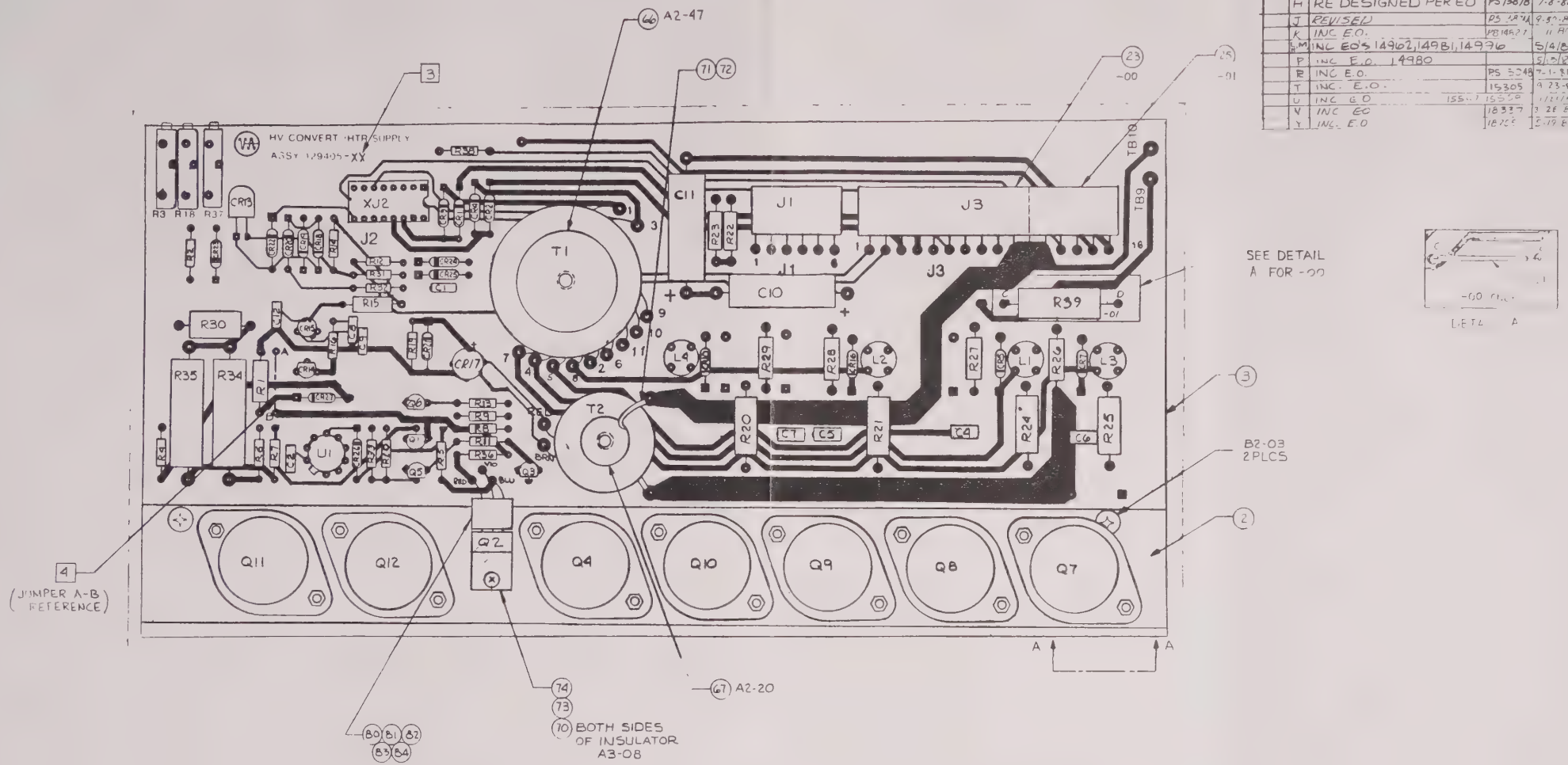
CONTRACT NUMBER
DR [illegible] 5-25-77
CHK [illegible]
APPD [illegible]
APPD [illegible]
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

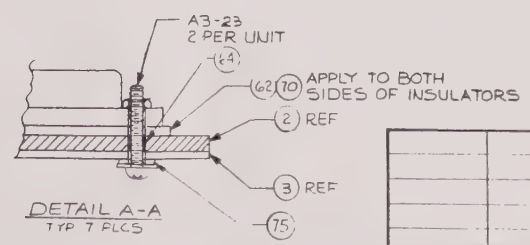
varian — MICROWAVE EQUIPMENT OPERATIONS, SANTA CLARA CALIFORNIA

HV CONVERTER & HTR SUPPLY SCHEMATIC

SIZE D | CODE IDENT NO 52787 | 129402 | J

ZONE	LTR	DESCRIPTION		DATE	APPROVED
	A-G	PER EO'S PS12243, PS12520 PS12477, PS12606	PS12955 PS13128	5-2-79	
	H	RE DESIGNED PER EO	PS13878	7-8-80	
	J	REVISED	PS [illegible]	9-5[illegible]	[illegible]
	K	INC E.O.	PB14827	[illegible]	[illegible]
	L-M	INC EO'S 14962, 14981, 14996		5/4/81	LMH
	P	INC E.O. 14980		5/13/81	JHT
	R	INC E.O.	PS 3048	7-1-81	[illegible]
	T	INC. E.O.	15305	9-23-81	[illegible]
	U	INC E.O. 155[illegible]	15559	[illegible]	[illegible]
	V	INC EO	18337	3-26-83	JS
	Y	INC. E.O.	18755	5-19-83	[illegible]





DETAIL A-A
TYP 7 PLCS

4 JUMPER A-B NOT REQUIRED REFERENCE ONLY.
(USE JUMPER A-B FOR RA HEATER SURGE CURRENT LIMIT)
3 MARK WITH CURRENT ASSY REV LETTER & DASH Nº.
2 ASSEMBLE USING HARDWARE PER DWG NO 110625.
NOTES: 1 ASSEMBLE PER VARIAN WORKMANSHIP STD 87-800299

SEE SEPARATE LIST OF MATERIALS - LM129405

LIST OF MATERIALS

NEXT ASSEMBLY	USED ON
E113979	100/200W

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER
DR L LAPPIN 7-1-80
CHK JAMES W. 7-9-80
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA CALIFORNIA

ASSEMBLY
HV CONVERT/HTR SUPPLY

SIZE D | CODE IDENT NO [illegible] | 129405 | Y
SCALE 2/1 | SHEET 1 OF 1

129405

varian | MICROWAVE EQUIPMENT OPERATIONS | TITLE H.V. INPUT CONVERTER PCB | LM 129405 | Y

CODE IDENT NO 597821 | APPROVAL | DATE | 0409A

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
E113979		R-47	A	ADDED VARIAN PART NO'S	-	11/18/77	
E113979			B	INC. E.O.	PS12243	12/9/77	JDD
			C	INC. E.O.	PS12477	10/3/78	MHS
			D	INC. E.O.	PS12520	10/3/78	MHS
			E	INC. E.O.	PS12606	10/3/78	MHS
			F	INC. E.O.	PS12955	9/10/80	AL/JDD
			G	INC. E.O.	PS13128	9/10/80	AL/JDD
			H	INC. E.O.	PS13878	9/10/80	AL/JDD
			J	INC. E.O.	PS13878A	9/30/80	JDD/JHT
			K	INC. E.O.	PS14827	11/11/80	AL/JDD
			L,M,N	INC. E.O.'S	14962, 14981, AND 14996	5/4/81	LMH/JHT
			P	INC. E.O.	14980	5/31/81	JHT
			R	INC. E.O.	15048	7/1/81	AJ/MS
			T	INC. E.O.	15305	8/23/81	RY/JR
			U	INC. E.O.	15558 & 15567	1/20/82	LA
			V	INC. E.O.	18337	3/28/83	JS
			Y	INC. E.O.	18705	5-19-83	AE

REVISION STATUS

SHEET																												
LTR																												
SHEET																												
LTR																												
SHEET																												
LTR																												

varian	MICROWAVE EQUIPMENT OPERATIONS	H.V. INPUT CONVERTER PCB	LM 129405	REV Y

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO -00	-01	-02	-03
1		SCHEMATIC	D129402			R	-		
2		HEATSINK	D135878			1	1		
3		FABRICATION, PCB	D129404			1	1		
4		SCHEMATIC	D135845			-	R		
5	C1,12	CAPACITOR, CERAMIC, 1uf, 50V	41-229936		CK06BX105K	2	2		
6	C2	CAPACITOR, CERAMIC, 100 pf, 200V	41-229960		CK05BX101K	1	1		
7	C4-7, C9	CAPACITOR, CERAMIC, .1uf, 100V	41-229952		CK06BX104K	5	5		
8	C8	CAPACITOR, CERAMIC, .01uf, 200V	41-229951		CK06BX103K	1	1		
9	C10,11	CAPACITOR, ALUM., 8.2 uf, 150V	41-506114	SPRAGUE	600D825F150DD4	2	2		
10	CR27	DIODE, 20V, 5W	66-393305		SX20	1	1		
11	CR24,25	DIODE, 75V, 5W, 10%	66-393016	UNITRODE	UZ4875	2	2		
12	CR23	DIODE	66-310751		1N751	1	1		
13	CR1-4,5,	DIODE	66-304936		1N4936	8	8		
	7,10,16								
14									
15	CR13	DIODE, LED, RED	67-499834	MONSANTO	MV5752	1	1		
16	CR14	SCR	66-600088		2N5054	1	1		
17	CR15	UNIJUNCTION	62-906119	UNITRODE	2N6119	1	1		
18	CR26	DIODE	66-314746		1N4746A	1	1		
19	CR17	SILICON BRIDGE	66-235012	VARO	VE-18X	1	1		

varian	MICROWAVE EQUIPMENT OPERATIONS	H.V. INPUT CONVERTER PCB	LM 129405	REV Y

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO -00	-01	-02	-03
20	CR22,CR18-20	DIODE	66-320914		1N914B	4	4		
21	CR21	DIODE	66-310758		1N758A	1	1		
22	J1	CONNECTOR, 6 PIN	51-407151	MOLEX	09-75-1061	1	1		
23	J3	CONNECTOR, 12 PIN	51-407156	MOLEX	09-75-1121	1	1		
24	L1-L4	INDUCTOR	C057664			4	4		
25	J3	CONNECTOR, 16 PIN	51-411007		09-75-1161	-	1		
26	Q5,6	TRANSISTOR	62-920019		MPSA56	2	2		
27	Q2	TRANSISTOR	62-798003		D44H11	1	1		
28	Q3,Q1	TRANSISTOR	62-920018		MPSA06	2	2		
29	Q4	TRANSISTOR	62-990211		MJ-1000	1	1		
30	Q7-10	TRANSISTOR	62-990175	MOTOROLA	MJ-10004	4	4		
31	Q11,12	TRANSISTOR	62-906254		2N6254	2	2		
32							-		
33	R1	RESISTOR, COMP 430 OHM, 5%, 1/2W	32-201343		RC20GF431J	1	1		
34	R3	RESISTOR, VARIABLE, 10K	36-792215	BOURNS	3006P-1-103	1	1		
35	R2	RESISTOR, COMP, 100K, 5%, 1/4W	32-301610		RC07GF104J	1	1		
36	R4	RESISTOR, COMP., 33.2K, +1%, 1/4W	31-225332		RC07GF333J	1	1		
37	R5	RESISTOR, COMP., 2K, 5%, 1/4W	32-301420			1	1		
38	R6,7,36	RESISTOR, COMP., 100 OHM, 5%, 1/4W	32-301310		RC07GF101J	3	3		
39	R8,9,33	RESISTOR, COMP., 3.3K, 5%, 1/4W	32-301433		RC07GF332J	3	3		

varian	MICROWAVE EQUIPMENT OPERATIONS	H.V. INPUT CONVERTER PCB	LM 129405	REV Y

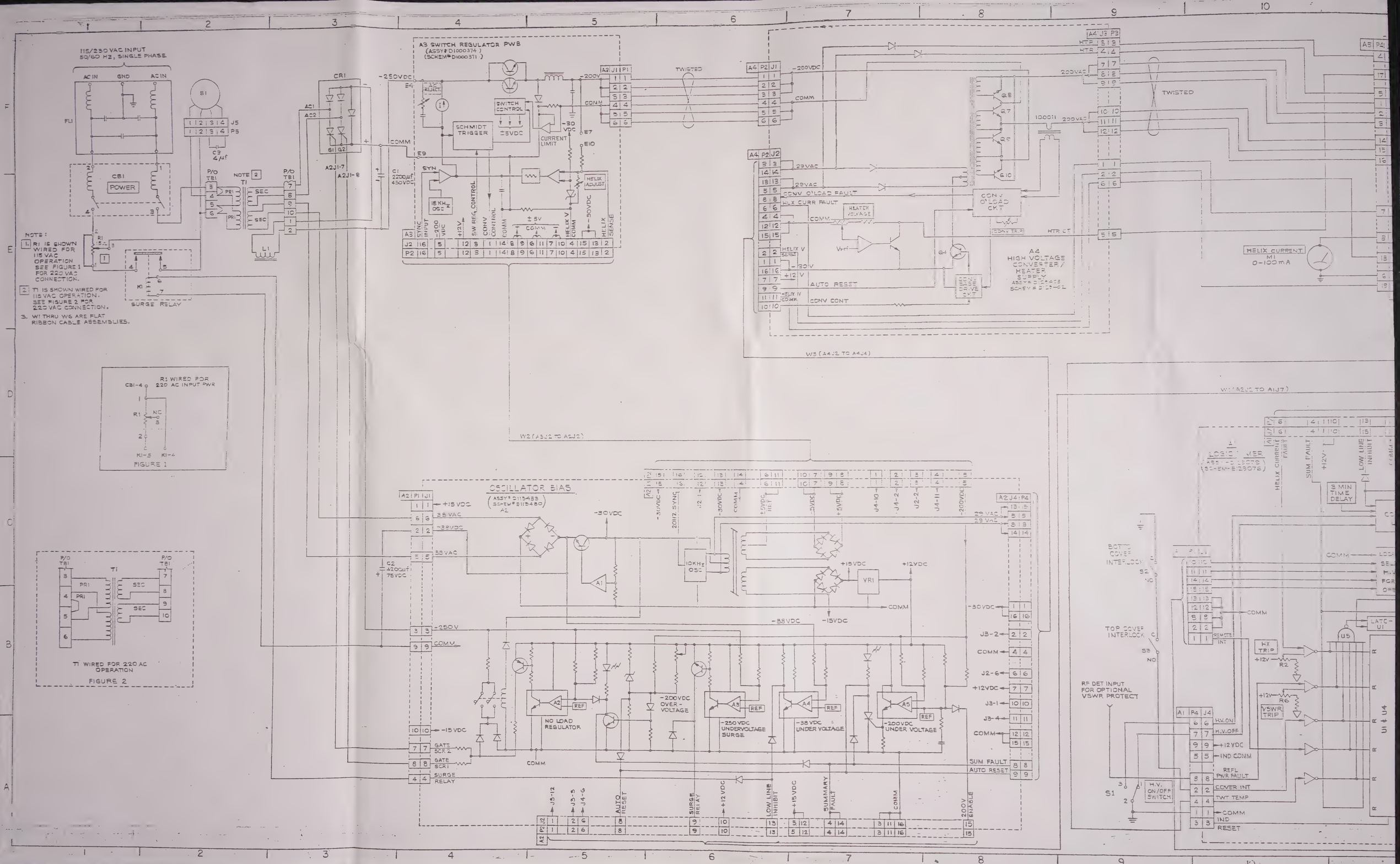
ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO			
						-00	-01	-02	-03
40	R10	RESISTOR, COMP., 15K, 5%, 1/4W	32-301515		RC07GF153J	1	1		
41	R11	RESISTOR, COMP., 4.7K, 5%, 1/4W	32-301447		RC07GF472J	1	1		
42	R12,13,31	RESISTOR, COMP., 33K, 5%, 1/4W	32-301533		RC07GF333J	3	3		
43	R14,16	RESISTOR, COMP., 1K, 5%, 1/4W	32-301410		RC07GF102J	2	2		
44	R15	RESISTOR, M.F., 1K, .1%, 1/4W	31-604100			1	1		
45	R38	RESISTOR, COMP., 27K, 5%, 1/4W	32-301527		RC07GF513J	-	1		
46	R18	RESISTOR, VARIABLE, 2K	36-792211	BOURNS	3006P-1-202	1	1		
47	R19	RESISTOR, M.F., 249 OHM, 1%, 1/4W	31-603249			1	1		
48	R20,21,	RESISTOR, W.W., 2 OHM, 1%, 3-1/4W	35-199119	OHMITE	4337	4	4		
	R24,25								
49	R22,23	RESISTOR, COMP., 100K, 5%, 1/2W	32-201610		RC20GF104J	2	2		
50	R26-29	RESISTOR, COMP., 56 OHM, 5%, 1/2W	32-201256		RC20GF560J	4	4		
51	R30	RESISTOR, W.W., 0.15 OHM, 10%	35-199131			1	1		
52	R32	RESISTOR, COMP., 100 OHM, 5%, 1/4W	32-301310		RC07GF101J	1	1		
53	R34,35	RESISTOR, W.W., 0.5 OHM, 3%	35-386050			2	2		
54									
55	T1	TRANSFORMER	C057661			1	1		
56	T2	TRANSFORMER	C057660			1	1		
57									
58	U1	I.C., POWER REGULATOR VOLTAGE	62-600500		UA723	1	1		
59									

varian | MICROWAVE EQUIPMENT OPERATIONS | H.V. INPUT CONVERTER PCB | LM 129405 | REV Y

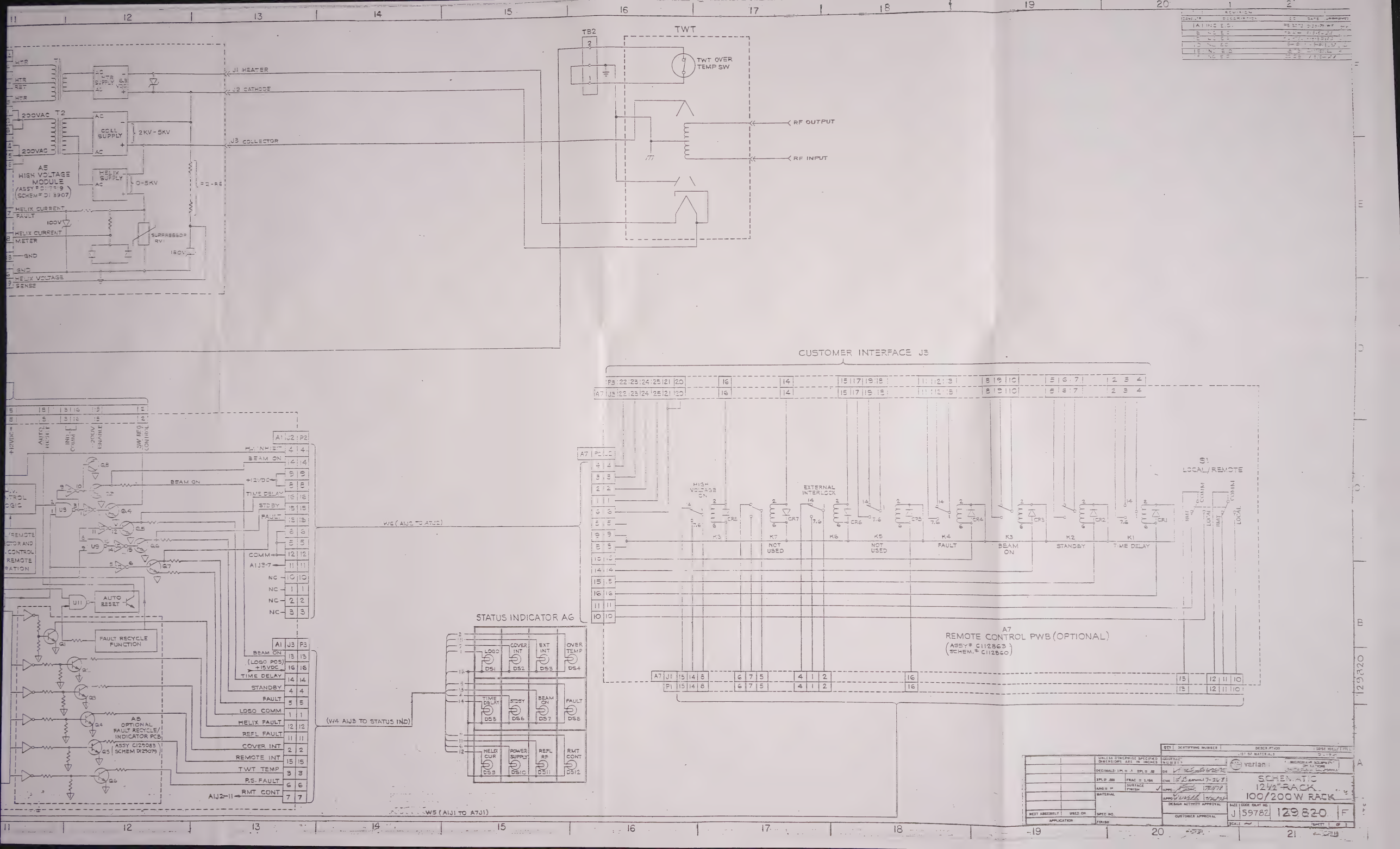
ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
60	J2	SOCKET, 16 PIN	54-634023	CKT ASSY CORP	16S-105D	1	1		
61	JPR-C-D	JUMPER - #20 AWG (USE ITEMS 71&72)				1	-		
62		INSULATOR, TO3 TRANSISTOR	62-898002	UNION CARBIDE	H-4001	7	7		
63									
64		BUSHING (3/16" LONG NYLON)	22-420029	AMATOM	9223-N-140	14	14		
65									
66		TOROID RETAINER #10-32	43-900002	DELBERT BLINN	100-6	1	1		
67		TOROID RETAINER #6-32	43-900001	DELBERT BLINN	100-3	1	1		
68									
69									
70		THERMAL COMPOUND	88-298900	WAKEFIELD	120-8	AR	AR		
71		WIRE, UNINSUL., COPPER #20	81-099920			AR	AR		
72		TUBING, INS., FIBERGLASS-SILICONE	88-495071			AR	AR		
73		INSULATOR, PLASTIC	62-899937	THERMALLOY	43-77-2	1	1		
74		WASHER, SHOULDER, NYLON	14-998043	SEASTROM	5607-45	1	1		
75		WASHER, INTERNAL TOOTH, #6	14-302006			14	14		
76									
77									
78	R37	RESISTOR, VAR., 50K	36-792210	BOURNS	3006P-1-503	-	1		
79	R39	RESISTOR, W.W., 0.25 OHM, 3W, 10%	31-588583	DALE	CP3-PW3	-	1		
80		WIRE, EE, RED, AWG 24	81-288722			AR	AR		

VARIAN	MICROWAVE EQUIPMENT OPERATIONS	H.V. INPUT CONVERTER PCB	LM 129405	REV Y

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO			
						-00	-01	-02	-03
81		WIRE, EE, VIO, AWG 24	81-288766			AR	AR		
82		WIRE, EE, BLU, AWG 24	81-288766			AR	AR		
83		SOCKET	54-612954	MOLEX	10-01-2D31	1	1		
84		PINS	51-407012	MOLEX	08-50-0108	3	3		

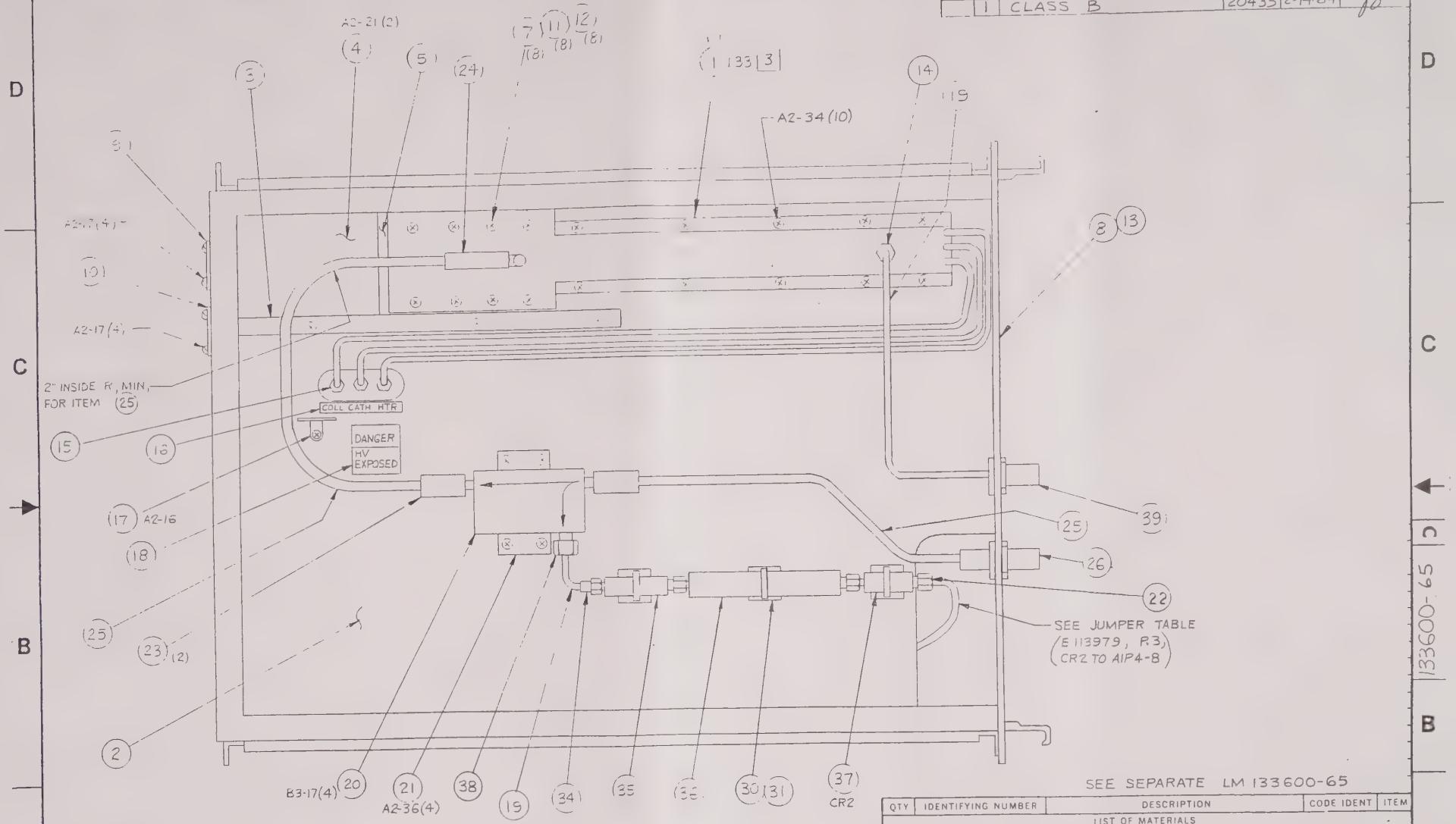


115/230 VAC INPUT
50/60 HZ, SINGLE PHASE
AC IN
GND
AC IN
FL1
CB1
POWER
B1
J5
P5
C3
4 µf
P/O TB1
NOTE 2
T1
PR1
SEC
L1
CR1
A2J1-7
A2J1-8
C1
2200µf
450VDC
A3 SWITCH REGULATOR PWB
(ASSY# D1000374)
(SCHEM# D1000371)
-250VDC
COMM
SCHMIDT TRIGGER
SWITCH CONTROL
±5VDC
CURRENT LIMIT
-30 VDC
HELIX ADJUST
15 KHz OSC
SYN
SYNC INPUT
-200 VDC
+12V
SW REG CONTROL
CONV CONTROL
COMM
±5V
HELIX V COMM
-30VDC
HELIX SENSE
TWISTED
-200VDC
COMM
29VAC
CONV O'LOAD FAULT
HLX CURR FAULT
HEATER VOLTAGE
CONV O'LOAD CKT
CONV TRIP
HTR CT
HELIX V SENSE
-30V
+12V
AUTO RESET
HELIX IV COMM
CONV CONT
CONV BASE DRIVE CKT
A4
HIGH VOLTAGE CONVERTER/ HEATER SUPPLY
ASSY# D129403
SCHEM# D129402
1000:1
200VAC
HTR
HELIX CURRENT
M1
0-100 mA
NOTE:
1. R1 IS SHOWN WIRED FOR 115 VAC OPERATION SEE FIGURE 1 FOR 220 VAC CONNECTION.
2. T1 IS SHOWN WIRED FOR 115 VAC OPERATION. SEE FIGURE 2 FOR 220 VAC CONNECTION.
3. W1 THRU W6 ARE FLAT RIBBON CABLE ASSEMBLIES.
SURGE RELAY
K1
R1 WIRED FOR 220 AC INPUT PWR
CB1-4
NC
K1-5
K1-4
FIGURE 1
T1 WIRED FOR 220 AC OPERATION
FIGURE 2
W3 (A4J2 TO A4J4)
W2 (A3J2 TO A2J2)
W1 (A2J2 TO A1J7)
OSCILLATOR BIAS
(ASSY# D115483)
(SCHEM# E115480)
A2
+15VDC
38VAC
-38VDC
-30VDC
C2
4200µf
75VDC
10KHz OSC
VR1
+15VDC
+12VDC
-15VDC
-250V
COMM
-15VDC
GATE SCR2
GATE SCR1
SURGE RELAY
NO LOAD REGULATOR
REF
-200VDC OVER-VOLTAGE
-250VDC UNDERVOLTAGE SURGE
-38VDC UNDER VOLTAGE
-200VDC UNDER VOLTAGE
SUM FAULT
AUTO RESET
J3-2
J2-6
+12VDC
J3-1
J3-4
J3-12
J3-5
J4-6
AUTO RESET
SURGE RELAY
+12VDC
LOW LINE INHIBIT
+15VDC
SUMMARY FAULT
COMM
200V ENABLE
LOGIC TIMER
HELIX CURRENT FAULT
SUM FAULT
+12V
LOW LINE INHIBIT
3 MIN TIME DELAY
BOTTOM COVER INTERLOCK
TOP COVER INTERLOCK
REMOTE INT
HX TRIP
VSWR TRIP
RF DET INPUT FOR OPTIONAL VSWR PROTECT
H.V. ON
H.V. OFF
+12VDC
IND COMM
REFL PWR FAULT
COVER INT
TWT TEMP
COMM
IND
RESET
H.V. ON/OFF SWITCH
S1
S2
S3
U1 & U4
U5
LATCH U1



TWT
TB2
TWT OVER TEMP SW
RF OUTPUT
RF INPUT
J1 HEATER
J2 CATHODE
J3 COLLECTOR
HTR SUPPLY
COLL SUPPLY
HELIX SUPPLY
2KV-5KV
0-5KV
A5 HIGH VOLTAGE MODULE
HELIX CURRENT FAULT
HELIX CURRENT METER
HELIX VOLTAGE SENSE
SUPPRESSOR RV1
CUSTOMER INTERFACE J3
HIGH VOLTAGE ON
EXTERNAL INTERLOCK
NOT USED
FAULT
BEAM ON
STANDBY
TIME DELAY
S1 LOCAL/REMOTE
A7 REMOTE CONTROL PWB (OPTIONAL)
(ASSY# C112863 SCHEM.# C112860)
W6 (A1J2 TO A7J2)
W5 (A1J1 TO A7J1)
(W4 A1J3 TO STATUS IND)
STATUS INDICATOR A6
LOGO
COVER INT
EXT INT
OVER TEMP
TIME DELAY
STDBY
BEAM ON
FAULT
HELIX CUR
POWER SUPPLY
REFL RF
RMT CONT
AUTO RESET
FAULT RECYCLE FUNCTION
A8 OPTIONAL FAULT RECYCLE/ INDICATOR PCB
(ASSY C129083 SCHEM D129079)
BEAM ON
TIME DELAY
STDBY
FAULT
COMM
NC
LOGO COMM
HELIX FAULT
REFL FAULT
COVER INT
REMOTE INT
TWT TEMP
P.S. FAULT
RMT CONT
SCHEMATIC
12½" RACK
100/200W RACK
J 59782 129820 F

REVISIONS					
ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	1	CLASS B	20435	2-14-84	



SEE SEPARATE LM 133600-65

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

[3] APPLY A UNIFORM THIN COATING OF HEATSINK COMPOUND, ITEM (33), TO ITEM 1 BEFORE INSTALLATION.

2. ASSEMBLE USING HARDWARE DWG. C110625.
1. ASSEMBLE PER VARIAN STD 87-800299.

NOTES:

	VZC6963GIB
NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS: 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER

DR	A. ERMIDES	2-14-84
CHK		
APPD		2/16/84
APPD		

DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA, CALIFORNIA

ASSEMBLY MODIFICATIONS VZC 6963 GIB

SIZE	CODE IDENT NO	
C	59782	133600-65 1

SCALE 1/2 | CLASS B | SHEET 1 OF 1

133600-65

MICROFILM

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE: ASSEMBLY MODIFICATION VZC-6963G1B	LM133600-65	REV 1
CODE IDENT NO 59782	APPROVAL [signature]	DATE 2/17/84		0450A

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
	VZC-6963G1B		1	CLASS B	20435	2-24-84	[signature]

REVISION STATUS

SHEET																										
LTR																										
SHEET																										
LTR																										
SHEET																										
LTR																										

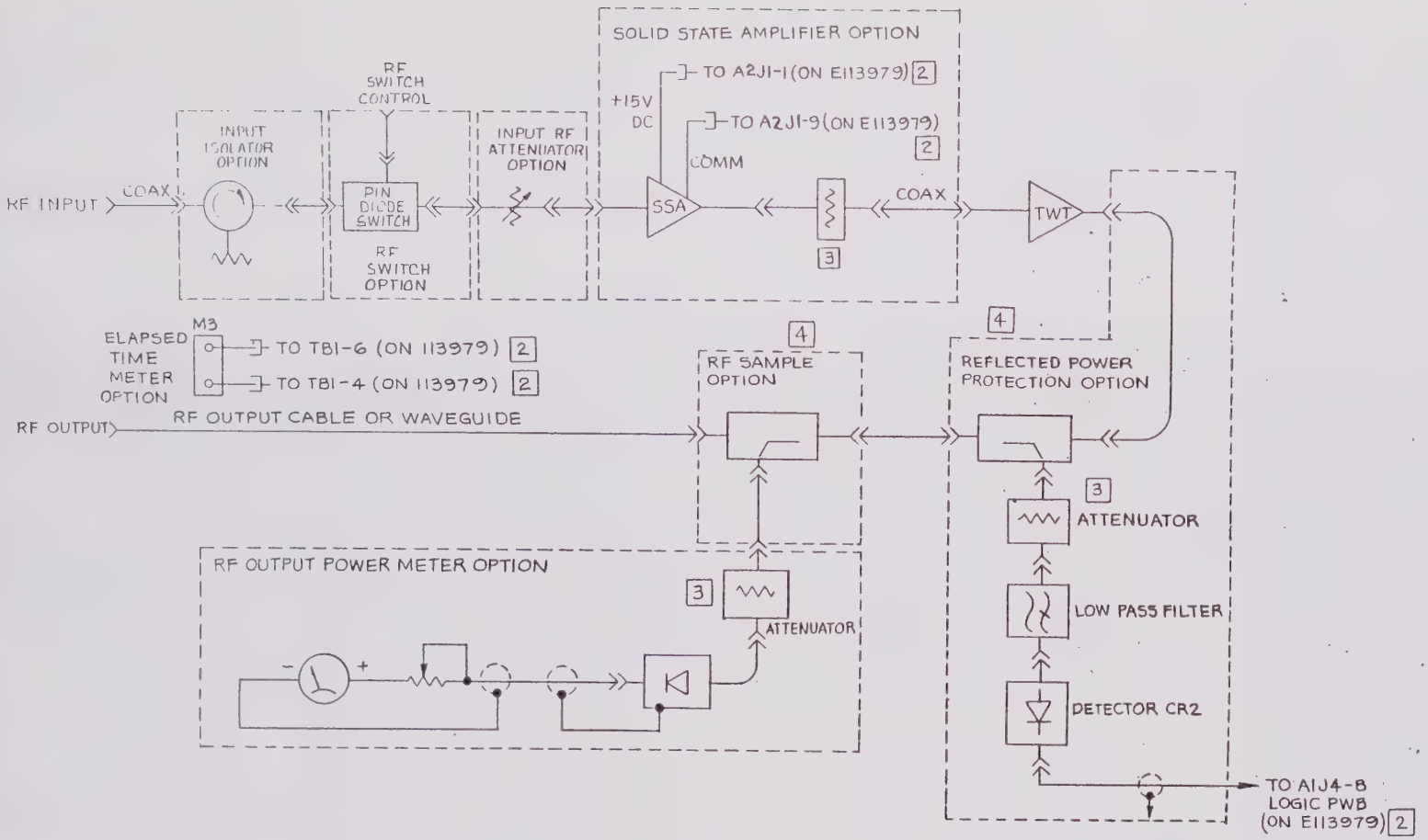
varian	MICROWAVE EQUIPMENT OPERATIONS	ASSEMBLY MODIFICATION VZC-6963G1B	LM 133600-65	REV 1

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO	QTY/DASH NO			
						-00	01	-02	-03
1	V1	TWT		VARIAN	VTC 6262F1	1			
2		BASIC POWER SUPPLY	E113979-18			1			
3		SUPPORT BAR	B129809			1			
4		TUBE PLATE	C129709			1			
5		HEATSINK	C113999			1			
6		RF SCHEMATIC	C134983			R			
7		SCREW, 8-32 x 1-1/2, RH, PH, S.S.	12-222008-24			8			
8		FRONT PANEL, LOWER	D135105-01			1			
9		COVER PLATE, RF OUT	C129811-00			1			
10		COVER PLATE, RF IN	B129810-03			1			
11		PLAIN WASHER, #8	14-122008			8			
12		LOCKWASHER, #8	14-202008			8			
13		SPACER, FRONT PANEL	A112882-02			1			
14		SMA PLUG, .141 CABLE	58-180100	OSM	201-1	1			
15		CONNECTOR, HV MALE	51-231851			3			
16		LABEL: COLL-CATH-HTR	A129711			1			
17	TB2	TERMINAL STRIP	56-299903			1			
18		LABEL: HV	B112465-00			1			
19		CABLE, COAXIAL, SEMI-RIGID, .141	82-299901			AR			
20	DC1	DIRECTIONAL COUPLER 30dB	83-330009	NARDA	3004-30	1			
21		SUPPORT PLATE, COUPLER	B133034			1			

Varian	MICROWAVE EQUIPMENT OPERATIONS	ASSEMBLY MODIFICATION VZC-6963G1B	LM 133600-65	REV 1

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO	QTY/DASH NO			
						-00	01	-02	-03
22		SMA, PLUG RG-188/U	58-180107	OMNI SPECTRA	2031-5003-00	1			
23		CONN, N PLUG, FOR 3/8 CABLE	58-180182	OSM	3001-7575-00	2			
24		CONN, TNC, FOR 3/8 CABLE	58-180152	OSM	3101-7575-00	1			
25		.375 DIA. HIGH POWER LOW-LOSS	32-999905	ESSEX	421-227	AR			
		SEMI-RIGID							
26		N JACK, BULKHEAD, HI POWER	58-180153	OSM	OSN410-A375	1			
27									
28									
29									
30		MOUNT, CABLE TIE	22-119603	PANDUIT	ABNS-A	5			
31		CABLE TIE	22-119650	PANDUIT	SST1M	5			
32									
33		HEATSINK COMPOUND	88-298900			AR			
34		SMA JACK	58-180117	OSM	202-1A	1			
35		ATTENUATOR	83-439878	TEXSCAN	FP-87, 20dB, SMA	1			
36		LP FILTER	83-460010	RLC ELECT.	F-30-8000-R	1			
37	CR2	DETECTOR	83-450110			1			
38		TYPE N PLUG, .141 CABLE	58-180183			1			
39		N JACK, BULKHEAD	58-180179	OSM		1			
40						1			
41									

B	INC. E.O.	2011	1-16-84	RO	D.M



4 IF BOTH RF SAMPLE & REFLECTED POWER OPTIONS ARE INCLUDED, A DUAL COUPLER MAY BE USED.

3 ATTENUATOR VALUES ARE DETERMINED IN TEST.

2 E113979 IS THE ASSEMBLY DWG FOR THE 12 1/4 RACK, 100/200 W TWTA.

1 THIS SCHEMATIC IS TO BE USED IN CONJUNCTION WITH E129820, SCHEMATIC FOR THE 2 1/4 RACK, 100/200 W TWTA.

NEXT ASSEMBLY	USED ON
	100/200 W

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

DECIMALS: 1PL ± .1 2PL ± .02

3PL ± .005 FRAC ± 1/64

ANG ± 1° SURFACE FINISH ✓

MATERIAL

SPEC NO.

FINISH

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS R302

CONTRACT NUMBER

DR	Tillie Evans	79-10-26
CHK		
APPD	[signature]	10/29/79
APPD		

DESIGN ACTIVITY APPROVAL

CUSTOMER APPROVAL

varian

MICROWAVE EQUIPMENT OPERATIONS SANTA CLARA, CALIFORNIA

RF SCHEMATIC 100/200 W TWTA

SIZE	CODE IDENT NO.		
C	59782	134983	B

SCALE ~ SHEET 1 OF 1

SUPERSEDES

VSWR PROTECTION CIRCUIT OPTION

1.0 INTRODUCTION

This discussion supplements the information on the standard unit presented in Sections 1 through 7 of this manual and describes the VSWR Protection Circuit option.

2.0 DESCRIPTION

The standard unit is equipped with a directional coupler. The VSWR Protection Circuit Option adds an attenuator, a low pass filter, a microwave tunnel diode and associated cabling. The diode converts reflected RF power into a signal that can be used to trip a fault detection circuit (see RF schematic). This precludes damage to the TWTA from a high VSWR (excessive mismatch) condition.

3.0 THEORY OF OPERATION

The TWTA is designed to feed into an RF load that has impedance characteristics that match those of the TWTA. When there is a mismatch, some of the RF power output of the TWTA is reflected back into the TWTA. In general, it is desireable to operate with a minimum of reflected power. The VSWR Protection Circuit trip point can be set for a specific value of reflected RF power. A microwave tunnel diode is connected to the reverse power port of the directional coupler. The tunnel diode converts the RF input to a proportional analog DC signal that can be used to actuate the logic circuits. The DC signal is routed to the logic board (see schematics in Section 7).

Referring to the logic board schematic, the DC output of the tunnel diode is applied through 10K resistor 1A2R4 to pin 6 of 1A2U7 and compared to a preset reference voltage on pin 5 of 1A2U7. The VSWR trip point can be adjusted using variable resistor 1A2R6. This trip point is set for a reflected power level of about 10% forward power.

HIGH VOLTAGE EQUIPMENT PERSONNEL OPERATING GUIDELINES

1.0 INTRODUCTION

This guideline document presents operating practices for operators and technicians who work with high voltage equipment. In the context of this discussion any voltage that is lethal is viewed as "high voltage". Therefore, even prime power (115 to 440 VAC) is dangerous because prime power potentials have been known to cause death or injury. (See Section 2.0)

THERE ARE NO OLD CARELESS HIGH VOLTAGE TECHNICIANS

Electrical circuits operate quickly and do not allow a careless individual a second chance. When dealing with high voltage, the results are very consistent and predictable and hazards associated with high voltage are always present. THE FACT THAT THE CONTROL SWITCH SAYS OFF DOES NOT MEAN YOU ARE SAFE. Many high voltage circuits are like loaded guns. IN GENERAL, YOU CANNOT SEE A HIGH VOLTAGE HAZARD. You can learn to recognize situations that present a threat and how to avoid them.

The guidelines presented in this guide are not academic. They are based on the experience of engineers and technicians who have years of experience with high voltage circuits.

2.0 WHEN IS VOLTAGE "HIGH"?

As stated earlier, any voltage that will kill you should be treated as "high voltage". Voltages associated with prime power generally do not jump the air gap between people and the equipment. Usually exposed circuit elements such as a terminal, bare piece of wire, or some other non-insulated surface must be touched. One of the problems associated with prime power is that some equipment can be "floating" above ground. In this case, if you place one hand on the equipment chassis and the other on on

earth ground you can be jolted, injured or killed. 440 VAC can stimulate an involuntary muscle response that will either literally throw you across a room or seize and hold you across the voltage terminals. 600 or more volts can hold you indefinitely. If the potential is sufficient to drive 200 milliamps through your body you will be held indefinitely. Some people consider the 200 to 600 volt range to be worse than potentials of thousands of volts.

3.0 GENERAL GUIDELINES

In addition to the above, the following practices have proven effective for personnel who deal with high voltage equipment.

a. HANDS OFF. Avoid contact with any potential source of high voltage. Keep your hands out of the equipment when it is operating.

b. AVOID ACCIDENTAL CONTACT. Make sure that some other part of your body does not come in contact with the high voltage circuits. It is easy to forget the hazards when you are concentrating on a frustrating or interesting task. Pens and badges in shirt pockets could cause contact.

c. NEVER WORK ON HIGH VOLTAGE CIRCUITS WHEN YOU ARE ALONE. If anything should happen to you, your only chance may be prompt action by some other person. Be sure someone else is present and knows what to do in an emergency. (eg. how to shut the equipment off, first aid, who to call, etc.)

d. USE ONE HAND WHEN WORKING WITH HIGH VOLTAGE CIRCUITS. Many people recommend that you put one hand in your pocket when you use a probe or other piece of equipment inside a high voltage section.

i. TAKE PERSONAL RESPONSIBILITY TO ASSURE THAT NO ONE CAN TURN ON THE HIGH VOLTAGE CIRCUITS WHEN YOU ARE WORKING ON THE EQUIPMENT. Precautions would include taping down (or installing keepers) on controls/circuit breakers and/or disconnecting the power source to the high voltage circuits, activating interlocks that prevent high voltage turn on etc. Know where the disconnects are and use them. Do not rely on anyone not to turn on the high voltage.

j. SET UP YOUR TEST EQUIPMENT WITH THE POWER OFF. Conduct the power-on operations when you have your hands out of the equipment.

k. DO NOT USE SHORT PROBES FOR HIGH VOLTAGE MEASUREMENTS. A short probe does not allow any margin for error. If your hand slips you could accidentally come into contact with a danger point. A long probe avoids the whole problem.

l. READ THE INSTRUCTION MANUAL. The best insurance is foreknowledge of hazards.

m. CREATE A FAVORABLE ENVIRONMENT FOR SAFE OPERATIONS. This means that if people are crowding about you, stop the operation if it involves high voltage. Pressure can lead to carelessness. In the same way, fatigue is also an enemy. STAY ALERT AT ALL TIMES WHEN WORKING WITH HIGH VOLTAGE.

n. DO NOT BECOME OVER CONFIDENT. Maintain a healthy respect for high voltage.

o. A GOOD OPERATING PRACTICE IS TO CHECK THE POTENTIAL BETWEEN THE EQUIPMENT CHASSIS AND EARTH GROUND BEFORE YOU COMPLETE THE CIRCUIT WITH YOUR BODY. As voltage levels increase, the protection you get from insulation and air gap diminishes. For example, in a piece of equipment that involves beam voltages of about 16 KV, the beam transformers look very safe with massive insulation on the outside of the coils. Physical contact with the beam coil when the system is operating can be fatal. Although the equipment is placarded to warn people of the presence of high voltage, it is virtually impossible to placard every point of danger in a system.

p. IF YOU DO NOT KNOW HOW THE EQUIPMENT WORKS AND WHAT THE HAZARDS ASSOCIATED WITH THE EQUIPMENT ARE IN SPECIFIC TERMS, DO NOT HANDLE THE EQUIPMENT. The greatest protection you can have when dealing with high voltage equipment is specific, detailed knowledge on that particular piece of equipment.

q. AVOID "HAYWIRE" TEST SETUPS. It is easy to get in trouble if the setup you are using has a jumble of wires.

r. MAKE SURE YOUR CONNECTIONS ARE SECURE. Do not allow leads to slip off and move about in an uncontrolled fashion. Even if it is not one of the high voltage leads, a free lead could (and generally does) move exactly to where you do not want it. The only safe connection is a mechanically secure one.

s. WATCH OUT FOR UNTERMINATED HIGH VOLTAGE LEADS. Some connectors depend on circuit loading to avoid arcing between closely spaced terminals. Unloaded high voltage lines or plugs can lead to arcing situations.

t. SHUT OFF THE HIGH VOLTAGE WHEN YOU ARE MAKING LOW VOLTAGE MEASUREMENTS. It does not make any sense to increase danger needlessly. While there may be times when you cannot shut off the high voltage during a low voltage measurement this is generally not the case.

u. REMOVE THE TEST EQUIPMENT WHEN YOU HAVE FINISHED A MEASUREMMENT PROGRAM. There has been many instruments destroyed or damaged because a test program was conducted in a haphazard manner rather than in an orderly progression from start to finish. Experience has shown many instances when a little order would have prevented a tragedy or avoided an expensive mistake.

v. BE EXTREMELY WARY WHEN MAKING FILAMENT VOLTAGE MEASUREMENTS. The cathode of tubes is elevated above (or below) ground and the filament voltages usually cannot be made with reference to ground. Do everything you can to assure that the high voltage cannot be turned on when you are making your measurements. This includes disconnecting the high voltage drive source, shorting out appropriate leads, taping down switches and anything else you can think of to protect yourself.

w. WHEN TROUBLE SHOOTING A UNIT ASSUME THAT THE SWITCHES AND COMPONENTS ARE DEFECTIVE. You may shut off the high voltage switch in some systems, but if the switch is defective you would still have the high voltage on. Returned units are potential booby traps.

x. MAKE SURE THAT YOUR WORK STATION IS STABLE. Flimsy work surfaces or supports for the equipment or the test instruments represent a real threat. Do not use a setup that you know is unstable and/or dangerous.

y. USE THE 30 SECOND RULE. Wait 30 seconds after you have shut off the equipment before you work on a unit. Part of the reason for the 30 second rule is that some of the dielectrics (insulators) used for high voltage circuits can store a charge. While the amount of charge stored is a function of the size of the object the 30 second rule provides an additional margin of safety.

z. MAINTAIN A HEALTHY RESPECT FOR ANY KIND OF LIVE CIRCUITS. COMPLACENCY CAN HURT YOU OR KILL YOU. Your continued wariness is your best insurance against injury or death.

MICROWAVE RADIATION PERSONNEL OPERATING GUIDELINES

1.0 INTRODUCTION

This guideline document presents operating practices appropriate for operators and technicians who work with equipment involving microwave radiation. Keep in mind that levels of microwave radiation that do not induce immediate physical discomfort in most individuals can be sufficiently high to induce longer term effects. Varian MCSD equipment usually is related to amplification of an RF signal from an external source. Even if a source is not connected to the amplifier you are working with, there are situations where the amplifier can go into a self induced mode and generate high levels of RF energy. This condition can exist if the unit is operataed with the high voltage on and without proper termination on the input and output of the amplifier.

> PROTECT YOURSELF AND THOSE AROUND YOU FROM UNWANTED RF EXPOSURE. ALWAYS TERMINATE THE AMPLIFIER INPUT AND OUTPUT WITH A RF DUMMY LOAD (or a short) BEFORE YOU TURN THE HIGH VOLTAGE ON. This will reduce the chances of oscillation due to internal amplifier noise.

2.0 DISCUSSION

Limit exposure to microwave radiation to prevent unwanted biological effects. There are other effects that can lead to problems if you are careless in operating or servicing microwave equiment. The permissable levels are quite low in comparison to the power levels of the amplifiers built by Varian. (eg less than 10 milliwatts vs 20 to 10,000 watts delivered by different units). Local radiation levels can be detected with the proper equipment. The permissable levels are currently being studied by a number of organizations. In the past the US Safety codes estab-

lished a dozage rate number of 10 mw/cm. sq. Currently there is consideration being given to reducing the permissable level to 1 mw/cm. sq. in the United States as has been the case for several European countries.

3.0 GENERAL GUIDELINES

The purpose of these guidelines is to provide practical approaches to control unwanted microwave energy associated with the operation and servicing of Varian equipment. The following approaches are effective in both laboratory or field environments.

a. ALWAYS TERMINATE THE OUTPUT WAVEGUIDE OR CONNECTOR WITH A DUMMY RF LOAD (CAPABLE OF DISSIPATING FULL CW RF POWER) OR AN APPROPRIATE SHORT. SIMILARLY, TERMINATE THE INPUT TO AVOID THE POSSIBILITY OF THE AMPLIFIER BEING DRIVEN BY STAY LEAKAGE SIGNALS. Incorporate the terminations prior to applying prime power to the amplifier. This procedure prevents self oscillation and irradiation of the local environment.

b. DO NOT LOOK INTO THE OUTPUT PORT OF A POWERED RF AMPLIFIER. Treat the powered amplifier as though it is a loaded gun. Your eyes are particularly vulnerable parts of your body.

c. SHUT OFF THE UNIT IF YOU ARE TRYING TO LOCATE AN RF LEAK. As noted earlier, the levels of concern are very low. Examine the physical unit with the high voltage off. If you have to survey the RF runs with the power on to find the leaky joint or component, start by testing the system with a radiation meter. If the microwave radiation exceeds 0.5 mw/cm. sq. shut off the high voltage and consult your supervisor. Work quickly (not at a panic pace) to minimize the dose level. The dose you get is directly proportional to the power level and the time you are exposed.

e. DO NOT FLOAT MEASURING EQUIPMENT ABOVE GROUND. Make all measurement with respect to ground. The odds are that if you float the instrument, you may forget and reach inside the equipment. Although it is harder to get the right test setup, it is well worth the effort.

f. DO NOT ASSUME THAT THE LEVEL OF RISK IS A FUNCTION OF SIZE. Some large high power high voltage equipment looks docile. One reason the equipment is so big is to get the proper separation between high voltage points. On the other hand, just because the equipment is small is no assurance of safety. Dense packaging results in more difficult access and increases the chance that you will accidentally hit the wrong point.

g. ALWAYS DISCHARGE HIGH VOLTAGE CAPACITORS. High voltage capacitors store a lot of energy for long periods of time. High voltage capacitors also exhibit a "memory" in that they can recover after discharge and reach lethal levels. In addition to the "memory" problem, there have been instances where the built-in safety features have failed or been miswired. Each and every time you go to work on a piece of high voltage equipment use a grounding rod with a long handle to discharge every high voltage capacitor.

h. DO NOT DEPEND ON THE AUTOMATIC FEATURES OF THE EQUIPMENT TO SAVE YOU. You never know when someone has left a circuit disabled, or if there has been a wiring error, or if a component has failed.

Exposure to microwave radiation can induce both thermal and non-thermal biological effects, especially with the eyes. If you damage the lens of your eye by exposure to microwave radiation, cataracts can result. Consider that small microwave ovens are very effecting in cooking foods. If you follow these guidelines you can minimize exposure of yourself and other people in the area to excessive levels of microwave radiation associated with the operations that you control.

MP MASTER
MA32712